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By Dr. MALCOLM BURR

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Improving the Sound Film

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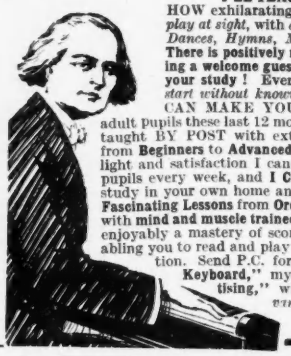

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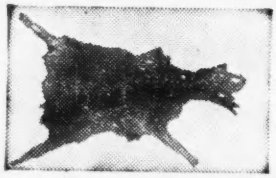

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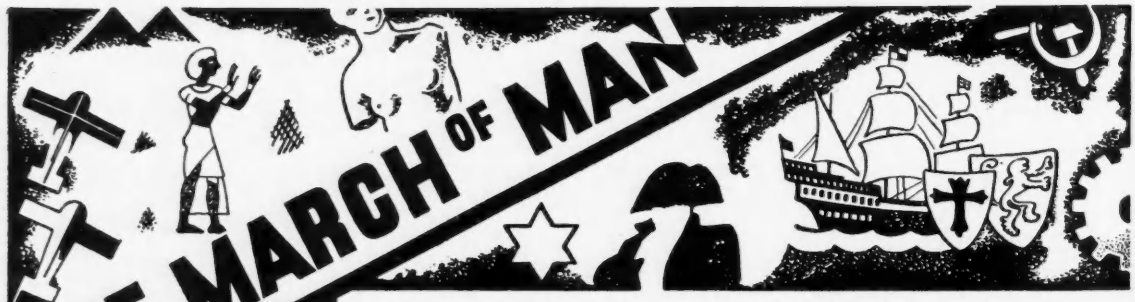

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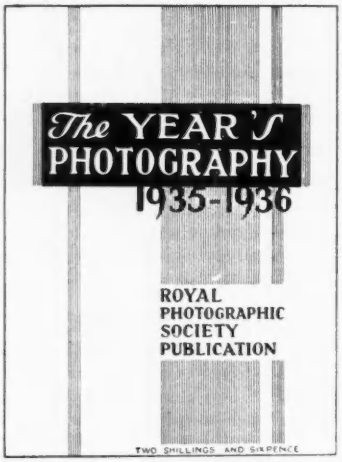

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Notes of the Month.

Abyssinia is a name that has been on every tongue since we last went to press, and an immense mass of untrustworthy information has been in circulation on the subject of Ethiopian civilisation, topography, art and so on. In fact, however, little that is new has been thrown into relief by the limelight of publicity. Last month, in one of our rare incursions on to the frontier of politics, we quoted the opinion of certain eminent scientists on the use of aircraft for bomb and gas attack on civilian populations. As far as there can be any thing pleasant to record about a war, it is gratifying to be able to state that—up to the time of writing—there has been little "air-frightfulness" in the Abyssinian campaign, and apparently no gas has been used, though one report spoke of an "irritant powder." Bombs certainly have been dropped, but in so thinly populated a country it is still legitimate to hope that their purpose was intended to be punitive rather than terrorising, in the same way as the bombs which our own airmen are accustomed to drop on evacuated villages on the North-West Frontier of India.

* * * *

Whatever the result of the war, one repercussion that it cannot fail to have is the lessening of the social and cultural isolation of Ethiopia. That country must inevitably come into closer contact with European civilisation (however unwillingly) and thereby lose much of its individuality. Meanwhile it is to be hoped that the fighting will not lead to the destruction of existing monuments of the old Amharic civilisation (the "monoliths" of Aksum, for example, would seem to be in grave danger); and, as soon as peaceful conditions once more prevail, some kind of ethnographical survey of the country should be quickly made before it becomes Europeanised—or will it be Americanised?

* * * *

Another step in the "civilisation" of Africa is the announcement that an agreement has been ratified for the utilisation of the power generated by the Zambezi water as it hurls itself over the Victoria Falls. A hydro-electric station with two generators of a capacity of 1,000 kW. each is to be installed in the neighbourhood of the Falls, which will supply electric power to the town of Livingstone. It is stated, of course, that the erection of the necessary buildings will in no way impair the beauty or impressiveness of the Falls; but the electric dragon is a greedy monster, and what has happened at Niagara is common knowledge (not to speak of the Falls at Tivoli, which work only on Sundays and holidays). Ironically enough it has been worked out that the profits from the tourist traffic at Niagara are greater than the maximum cash value that could be derived from using the power of the Falls to the full. Hence the Falls have become a National Monument, and untouchable for the future. Here is an argument that should be retained in the mind of the exploiters of the countryside, whether Rhodesian, American, or even British.

* * * *

Ornithologists and North Country people will be interested to learn of the project now on foot to create a permanent memorial to Viscount Grey of Fallodon, statesman and naturalist, in the capital of his native Northumberland. It is proposed that this shall take the form of a tablet, to be placed in the Hancock Museum, Newcastle-upon-Tyne, and the foundation of a trust fund, the income from which will be applied to the endowment of the Museum. The Hancock Museum, opened in 1884, ranks as one of the most notable British centres of natural history outside London, and its

fine collection of Bewick drawings is famous; but the scanty endowment has so far made it impossible to admit the public free of charge. The long period of local depression has made it yet more difficult to secure adequate funds for upkeep, and we readily broadcast Lord Armstrong's appeal for this excellent cause, coupled with the memory of a great Northumbrian, in the hope that North Country men all the world over may send their quota direct to the Treasurer at the Hancock Museum, Newcastle-upon-Tyne.

* * * *

The Dominion Department of Mines at Ottawa states that there is evidence of an increasing interest in the development of Canadian titanium-bearing deposits. Of the three titanium-bearing minerals which may be classed as ores, namely, rutile, ilmenite, and titaniferous magnetite, the known deposits in Canada that are both large enough and rich enough to be of commercial interest all occur in the provinces of Quebec and Ontario, more especially in Quebec, where ilmenite, carrying from 18 per cent. to 25 per cent. titanium, occurs in large bodies in several places. Rutile associated with the ilmenite in one of the deposits is the only commercial source of the mineral known in Canada. Titanium is used principally in the production of white non-poisonous pigments of great covering power and in alloys for use in steel-making. Rutile is used in the ceramic industry as a colouring material, especially in the manufacture of artificial teeth.

* * * *

The solution of the ever-recurring space problem, which affects museums, institutions, and the record departments of great industrial concerns, is furthered by a new method of keeping newspaper files and similar documents photographically. The *Newspaper World* describes the system, evolved by the Kodak Co., and known as "Newspaper Recordak." A year and a half of investigation and optical experiment has made it possible to record eight full-size newspaper pages on a strip of film measuring $1\frac{3}{4}$ in. by 12 in. This means in practice that a month's file of a 50-page newspaper can be stored in a space $3\frac{5}{8}$ by $3\frac{5}{8}$ by $1\frac{1}{2}$ in. Despite the extreme reduction in size involved, the clarity of the film image is such that by means of a viewing apparatus, any part of the page can be projected up to one and a half times its original size.

* * * *

The apparatus for viewing the film images is a projector measuring about 3 ft. in height, with a base 15 in. by 18 in., which can be loaded with a reel of 100-200 feet of film in a fraction of a minute. It casts the enlarged page material on a screen so shielded that subdued light is not necessary for reading. Any page out of the 800-1,600 included in a reel can be thrown on to the screen in a matter of seconds and scanned more rapidly than if the original news-print were being handled. Each column is projected 50 per cent. larger than actual size. The area of the screen is only one quarter of the enlarged page; an easily manipulated lever brings any required part of the page into view and it is seen not only magnified but isolated from surrounding matter. The film used will be of the safety type, which presents somewhat less fire hazard than ordinary newsprint, and the files will occupy so little space that duplicates made at the same time as the originals could be kept in a fire-proof safe or stored in a separate building. The application of this space-saving method of storage and viewing to other records besides newspapers is obvious.

* * * *

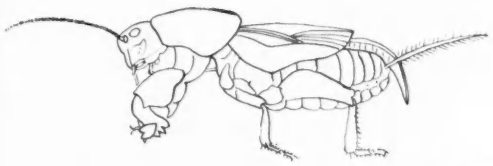
At the recent meeting of the Edinburgh and East of Scotland Sections of the Society of Chemical Industry and the Institute of Chemistry, Lieutenant-Colonel John du P. Langrishe, D.S.O., Lecturer in Public Health at Edinburgh University, said that statistical evidence showed a close relationship between death rates and atmospheric conditions. The number of deaths from pulmonary and heart diseases was shown to increase in direct proportion to an increase in the intensity and duration of smoke-fogs. He recalled the Meuse valley tragedy in Belgium in 1930, when a dense smoke fog over an area 20 miles long caused 65 deaths, mostly of elderly people, before it lifted. After an illuminating comparison of the amount of sunlight received at Manchester with that at places less than 10 miles distant, the speaker adverted to "the remote, yet highly important," influence on human health of the action of smoke on vegetation. "It has been shown, I believe," he said, "that pasturage in the neighbourhood of the industrial towns in Lancashire, which at one time supported 2 beasts to the acre, can now carry only one beast to 3 acres, while the milk of such cows is deficient in calcium. This is a very serious thing for children, whose diet consists so largely of milk, for, if their food is deficient in calcium, then not only is their growth retarded, but, worse still, they are liable to suffer from rickets." In support, Dr. Birkett Wylam, of the Department of Public Health for Scotland, and Mr. Alan M. Ritchie, Chief Sanitary Inspector of Edinburgh, made vigorous contributions to the cause of Smoke Abatement, but both, happily, were able to affirm that public opinion was at last roused to the urgency of the problem.

The Origin of the British Orthoptera.

By Malcolm Burr, D.Sc., F.R.Ent.S.

In the July number of DISCOVERY, *Dr. Zeuner discussed the origin of the English Channel. Dr. Burr here examines Dr. Zeuner's theory on the basis of the geographical distribution of our British Orthoptera.*

IN a most interesting and suggestive paper on the origin of the English Channel, in the July number of *Discovery*, Dr. Zeuner formulates the theory that the effect of the glacial period in Britain was almost completely to exterminate the then existing fauna and flora, and that our islands were restocked during the short period that elapsed between the improvement of the climate and the cutting of the Straits of Dover, by which England was isolated from the Continent; that is to say, between the latter part of the Boreal Period and early



Gryllotalpa gryllotalpa, L. (*The mole-cricket.*)

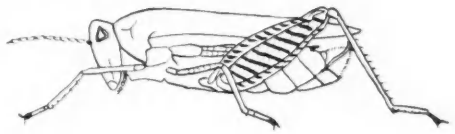
middle of the Atlantic Period, approximately between the years 10,000 and 4000 B.C. Great weight must be attached to Dr. Zeuner's opinion, for he is not only a geologist who has devoted considerable thought to glaciology, but also an experienced orthopterist, and, I may say, our only palæo-orthopterist. At the same time, his theory fails to account for certain problems of distribution, which seem explicable only on the hypothesis of survival from a pre-existing fauna. It seems worth while to ventilate the subject by the expression of views also of others, and I venture, therefore, to offer some observations based on the subject most familiar to me.

Our list of British Orthoptera is very meagre. When we have eliminated such exotics as have been introduced by artificial means and become established, such as the house cricket, and several cockroaches and earwigs, we have only thirty species to deal with, to which we may conveniently add our five indigenous earwigs, making a total of thirty-five. It is instructive to compare this with the corresponding fauna of the north of France, which is nearly double. The number of species of Orthoptera known in France, north of Paris, is sixty.

The origin of our British Orthoptera in the strict sense of the word has been discussed by Uvarov in a highly suggestive paper. This author has given so much thought to the subject, and based his opinion on so broad and profound a knowledge, that his conclusions must carry very great weight. But, unlike Dr. Zeuner, he bases his theories solely upon the facts of present distribution.

These two authorities differ on one point that is fundamental. Dr. Zeuner is convinced that the glaciers covered Great Britain with one vast simultaneous icefield that destroyed practically the entire fauna and flora, with the exception of a few arctic types, such as the white hare and ptarmigan, which managed to survive along the edges. He considers that in the tundra zone immediately surrounding the ice sheet conditions were much like those of Spitzbergen to-day. Then came the zone of grass and loess steppe with abundant life, many "glacial" mammals, and probably a fair number of insects, of the kinds adapted to a short summer. He maintains that the existing Orthoptera of central and western Europe require a longer summer, and therefore he thinks that hardly one of the species present in England to-day could possibly have persisted here from the Tertiary Period through the glacials. He declines to admit the possibility of Tertiary relicts surviving the glaciers in favoured places.

Uvarov, on the other hand, considers that no less than one quarter of our Orthoptera have survived from



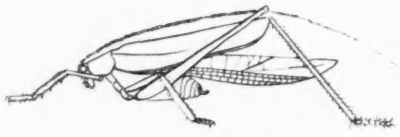
Acrydium vittatum, L.=*Kiefferi*, Saulcy.

Tertiary days, from "an ancient tropical fauna," basing his argument on the preference of these particular species for a moist climate. As instances, he quotes the subterranean mole cricket (*Gryllotalpa*), certain long-horned grasshoppers or Tettigonids, the wood and field crickets, and our three species of *Acrydium*, which are representatives of extensive groups that occur in the tropics as denizens of warm, and, above all, moist climates, bog-dwellers able to support the humidity of

the glacial epoch, which was more dangerous than the actual cold.

The Russian author admits that this group of his Tertiary survivors falls into two portions, each with a different history, for the field cricket and the two Tettigonids which he allots to this group are not characteristic of damp, but of dry, warm climates. Their existing relatives are mainly African, and to my mind they are survivors of that rich fauna which was once common to Europe and to Africa, when we shared the lion and the hippopotamus. The botanists would group with it such familiar genera as *Erica*, *Geranium*, *Linum*, *Helianthemum*, *Viola* and others. The field cricket in particular is a rarity with us, occurring in a few scattered localities, a characteristic relict distribution. I look upon it as clearly a member of that group which Scharff has called Lusitanian, an even more typical member of which is an elegant, spidery, green shrub or tree-hopper, which has been taken twice in the extreme corner of Cornwall, *Phaneroptera falcata* (Poda). I am hoping every summer to hear that someone has rediscovered this beautiful creature, and confirmed my opinion that it is an unquestionable member of our British list.

Uvarov has not noted one striking feature about the mole cricket, the wood cricket, and the three species of *Acrydium*, which are the hygrophilous group of his Tertiary survivors, and that is that the crickets and those queer, horny, brown little grasshoppers which we knew for so many years under the name of *Tettix*, but are now obliged to call *Acrydium*, have a life cycle different from that of our other Orthoptera, and from almost all Palæarctic Orthoptera. While the general rule is for the Orthoptera to hatch out from the egg in the late spring and become adult about the end of July, dying away in the late summer and autumn, to leave the ova through the winter, the crickets and *Acrydium* are adult in the early summer, die away about midsummer, when the young emerge from the egg, to appear as nymphs in the late summer, and hibernate in that condition,



Phaneroptera falcata, Poda.

attaining maturity in the following spring. I have never seen any suggested explanation of this striking difference of habit, and therefore venture to suggest that it is a survival of a cycle adapted to different climatic conditions, a souvenir of a past age, and that this very difference in habit from other Orthoptera is confirmatory of Uvarov's suggestion that these crickets

Leptophyes punctatissima, Bosc.

and the *Acrydium* have survived from an ancient tropical climate; that is to say, from Miocene days. Is it possible that this life cycle is retained from an origin in the southern hemisphere?

Another point that is strongly in favour of Uvarov's theory is the fact that the mole cricket and at least one of the Tettigonids, namely, *Leptophyes punctatissima* (Bosca), occur in Ireland. As Ireland was isolated from Britain before the glaciation, her fauna and flora are clearly of pre-glacial origin, and the existence of these two species, therefore, in Ireland shows that they are members of the Miocene fauna of our archipelago that have survived in Ireland.* Why, therefore, could they not have survived also in the south of England? It is to be noticed that *L. punctatissima* is a small, soft, obese, wingless, defenceless, sluggish insect, that can only crawl and give an occasional feeble hop, and spends its life on shrubs and bushes. That so stationary a creature should have been able to spread from France, across the land bridge, during the few thousand years allowed by Dr. Zeuner, and then somehow crossed the sea to Ireland, and established itself in Dublin and Co. Cork, is to my mind far more difficult to believe than the possibility of its having survived the glaciers in the mild and favoured climate of the south-west.

Uvarov's second group consists of five Tettigonids or long-horned grasshoppers. These interesting creatures are so unfamiliar to most Englishmen that we have no suitable name for them. The Americans call them "katydid" from their persistent song, but that is seldom noticeable in our country. We might perhaps call them shrub or bush-hoppers, to describe their habits and relationship to the grasshoppers. Now Uvarov looks upon these five as true relics of the "rich, xerothermic

*Ireland is famous for its number of relicts which can be interpreted only, to my mind, as survivors from the tropical days of the Tertiary. The most striking is a lichen, quoted by Mr. Einar du Reitz, *Sticta sinuosa*, which is a native of the rain forests of tropical America, and on this side of the Atlantic is found only in south-west Ireland.

fauna of the Atlantis," which was practically exterminated by the advent of humid conditions, leaving only a few survivals in more suitable habitats. Their relatives are all southern and Mediterranean, so this group coincides largely with Scharff's Lusitanian. I accept Uvarov's theory of the Atlantic fauna, at least on broad lines. He has elaborated it in other works, and made a most attractive theory. But two of his five Tettigonids to my mind require a different explanation. These are *Meconema thalassinum* (De G.) and *Decticus verrucivorus* (L.).

A Primitive European.

Sometimes a small, delicate, pale green, long-horned grasshopper is found on our windows, at least in the south of England, in the late summer and autumn. This is *M. thalassinum* (De G.) which lives on trees, chiefly oak and lime, and flies readily to light. The fact that it is characteristic of our damp woodlands, and can survive our moist autumn night into November is an argument, in my opinion, against a xerothermic origin. The sub-family to which it belongs is small, with few genera and an erratic distribution, a sure sign of great age. It is distinctive in being without stridulating organs. In Europe there are two genera, with three species, and an isolated monotypic genus in Tenerife, and I suspect it is that which makes Uvarov give it Atlantic origin. But the genus *Meconema* with its two species is confined to Europe, and, to my mind, it is in Europe that it has evolved. Scharff maintains that a portion of central Europe has been dry land from early geological times, sufficient to permit the evolution of what he terms a Germanic fauna, in support of which he quotes a snail, *Arianta arbustorum*, and the dormice. It is with these that I associate the Europen genus *Meconema*.

The other species which I cannot admit to Atlantis is a striking insect, *Decticus verrucivorus* (L.), the wart-biter, one of our largest British insects. In England it has been found only in a few scattered localities near the south coast—a typical relict distribution, on which ground Uvarov attributes it to Atlantis. But on the Continent it is a typically central and north European. In the south it is found only on mountains at a considerable height, being replaced in the lowlands by the xerothermic *D. albifrons* (Fabr.), which is surely Atlantic. *D. verrucivorus* is a familiar insect in Sweden, and ranges right across nothern central Europe, over Russia and Siberia. It is the commonest Tettigonid and the most characteristic in western Siberia, and reaches as far east as the river Amur. For that reason it does not seem to me to have derived from the continent of Atlantis, but from that other rich area of ancient evolution, eastern Siberia, to which Suess gave the name Angará, one of the most ancient parts of the earth's surface, taking the name from that crystal-clear, icy torrent that dashes out of Lake Baikal with such violence that even the Siberian frosts cannot lock it before February. It is to that Angaran fauna that I prefer to attribute *D. verrucivorus*. It is only a survivor in our country, but not so much owing to climatic conditions, as from the intense artificialisation of our countryside. To this same Angaran fauna Uvarov attributes two other Tettigonids, *Metrioptera brachyptera* (L.) and *M. roeselii* (Hagenb.). The former is found in peaty bogs in several localities in England, and the latter on grassy fields near the sea along the east coast, from Herne Bay to the Humber. I have no suggestion to offer to account for this curious distribution for an insect which in Europe is found up to a considerable altitude in the Alps and the Tirol.

But most characteristic of all are the true grasshoppers, of which we have ten kinds on our list. The ancient *horst* of Angará, covering the lands we now know as eastern Siberia and Mongolia, has been for such ages a grassy plain that it has permitted the evolution of a type of insect specially adapted to life in the grass. The farther east we travel towards Angará, the more numerous are the species of grasshopper, and that origin of the group is to my mind irrefutable.

A Siberian "Invasion."

But if there is little room for discussion about the centre of origin of the grasshoppers, there is plenty for debate on the date of their arrival. Uvarov writes of an "invasion" from Angará, and suggests that it came when loess steppe conditions prevailed over Europe in the Boreal Period. He synchronises it with the arrival on our east coast of the saigá antelope. He is, however, prepared to admit that it may have taken place as well just before as just after the glaciation.

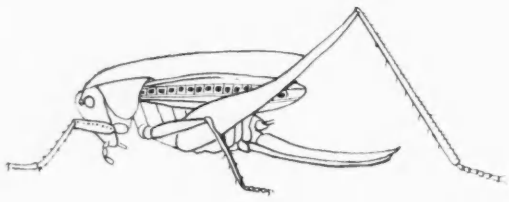
Here I disagree in detail. I cannot admit the synchronisation of these Angaran grasshoppers with what is known as the Siberian element in the European and British fauna, with the saigá, for instance, for the reason that no Siberian element has been reached in Ireland, for it clearly never crossed the Irish Sea, but yet these Angaran grasshoppers are well represented in Ireland. At least four species out of the ten are well known in our sister isle, and it is quite likely that most or all of the others will be discovered when more collecting has been done. And although these four are all undoubtedly arisen from the Angará steppe country they vary among themselves in their conditions of life. One speckled little fellow, for instance, *Myrmeleotettix maculatus* (Thunb.) likes dry, sandy ground, and is a common

object of our sandy heaths throughout Britain, including Ireland. Another, the largest and handsomest of our true grasshoppers, a dark green fellow with a yellow band down the elytra, *Mecostethus grossus* (L.), is found exclusively in bogs. Right across northern Europe it is to be found thus, in bogs and swamps, eastwards to Mongolia, westwards to Ireland, to the very Atlantic coast

One of the most characteristic and abundant grasshoppers of the Angará country to-day is a small green one, *Omocestus viridulus* (L.). It is not only almost the commonest grasshopper in this country, but the most widely distributed. It is found throughout Great Britain and in many parts of Ireland. Such a distribution is suggestive of an ancient origin, and I find it impossible to believe that such a species came after the glaciers or immediately before them. This Angaran population of ours must be far older. It must be older than the separation of Ireland.

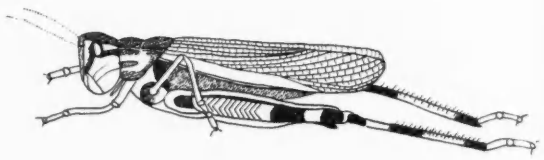
I think, too, that Uvarov has been unfortunate in his choice of words. "Invasion" gives the idea of a systematic, moving army; it is suggestive of an advance like that of the lemmings. "Migration," too, is unsuitable as that also conveys the idea of mass. To my mind, it is rather a matter of "peaceful penetration" of infiltration, proceeding slowly and imperceptibly through the ages.

Nor do I think it necessary to postulate, for the purposes of these grasshoppers, a simultaneous, vast extensive steppe. It is sufficient for their purpose to



Decticus verrucivorus, L. (*The wart-biter.*)

have a patch of grass. I can illustrate this point by a common observation. There is a genus of red-winged grasshoppers in southern Europe and all Africa that likes dry, desert ground, called *Acrotylus*. Wherever it finds a patch of such dry, dusty ground, there it arrives. In Central Africa I have watched it colonise a newly cleared area directly the vegetation was removed. Such patches, for the purposes of that *Acrotylus*, are deserts. They are, in fact, micro-deserts, and by them it can extend its range. So in the same way can grasshoppers pass from grass patch to grass patch, and so long as there is a sufficiently connected chain of patches they can continue to expand their range. Just as the dry, sandy-heath-loving *M. maculatus* may be found



Mecostethus grossus, L.

within a yard of the bog-loving *M. grossus*, where there is a boggy patch in a sandy heath, it is clear that it is not the regional characteristic of either ground or climate that matters, but the micro-region and the micro-climate.

Uvarov does not discuss our three little indigenous cockroaches, of the genus *Ectobius*. This is a purely European genus, distinguished by the peculiar venation of the wings. Shelford has shown that it occurs in Baltic amber of Oligocene age, and there is a famous passage in Linnaeus, where he describes how in Lapland *E. lapponicus* becomes a nuisance to the natives by eating their dried fish. So it was here in Oligocene days, and it is here to-day; it does not fear the climate of northern Scandinavia; the genus does not occur outside Europe or its immediate neighbourhood. Therefore I see no reason to look for its origin outside Europe. I rank it, without hesitation, with *Meconema*, with the snail *Arianta arbustorum*, and with the dormouse, in Scharff's Germanic fauna. It is a good European.

Air Humidity Control.

THE attention now given to the humidity of the air, as outlined in Dr. Hughes's article in our October issue, has brought apparatus for automatic control into the limelight. The new Humatagraph control, for example, utilises the strips from the outer fibre of the scales of ovular bracts of conifers. Nature has provided this substance with an extraordinary linear reaction to moisture—7½ to 10 per cent. from dry to saturation. Owing to this linear movement, and also to the absence of elasticity, this fibre can be harnessed direct to a mercury switch and avoid the necessity for relays. This means in practice the elimination of electrical contact points, always a source of trouble, as well as a lot of complicated mechanism.

These controls are constructed in two forms; in one the relaxation of the fibre by increment of moisture allows the mercury tube to tilt and break the current, and the current is thrown in again as soon as the air becomes dry. In the other form, most convenient where it is desired to dry the air by heat, the current is put on when the air becomes damp.

The Chocolate and Confectionery Industry.

By C. T. Williams.

Accustomed as we are to demanding high quality combined with moderate price in the confectionery that we eat, it may yet come as a surprise to many to read of the careful research and elaborate machinery that go to produce modern sweetmeats. British manufacturers are in the front rank in this branch of scientific industry.

By virtue of its antiquity, the confectionery industry commands attention. Authentic references are made to the preparation of confections in Egyptian hieroglyphics as early as 1566 B.C., and it is mentioned in the Book of Samuel in the Old Testament at a later date. During the 16th and 17th centuries, the *chefs* of the great European houses attained an amazingly high standard of decorative and manipulative skill in the reproduction of natural objects in sugar, and proficiency in the creation of entirely new sweetmeats. Thus the real foundations of this great industry, employing many millions of capital and over 100,000 workers in Great Britain alone, were laid by *chefs* in these interesting centuries.

[By courtesy of Messrs. Cadbury Brothers, Ltd.

Gathering the cocoa beans.

In the year 1828 a Dutchman named Van Houten conceived the idea of compressing the raw cocoa bean to produce cocoa powder and cocoa butter (comprising 50 per cent. of the raw bean). The former replaced chocolate, hitherto popular as a drink. The latter gave rise to the manufacture of eating chocolate as we know it to-day. Control of viscosity of eating chocolate is essential during its production and manipulation, and cocoa butter, extracted from the bean to be added at a later stage, is the most suitable fat for the purpose.

There are thirty-five varieties of cocoa bean, each possessing varying degrees of flavour intensity. The success of the products of the many great chocolate businesses throughout the world depends on the meticulous care exercised in the blending of certain types of these beans. In the usual course of their preparation for export, cocoa beans are fermented and dried, and these processes must be carried out with extreme exactitude as the ultimate character and flavour depend largely on these initial stages.

Contrary to widespread belief, chocolate and confectionery manufacture on a large scale is most intricate, scientific, and interest-compelling, and requires an amazing variety of productive plant. The most expensive and massive plant in the industry is that required for the production of chocolate and kindred products, as chocolate production is essentially a combination of heavy-mixing and comminution processes. To manufacture chocolate from the raw material even on a moderate scale would involve initial expenditure of several thousand pounds sterling on plant alone. In recent years, the general public has been enlightened through the medium of exhibitions, at which the latest mechanical developments are shown and explained, and conducted factory tours. To those who see the inside workings of the industry for the first time, the revelation is astonishing. Scientific control and research play a leading part in the successful production of all types of confectionery and chocolate. Scientific research has enlarged the manufacturers' knowledge of the characteristics of the raw materials used in the industry, and is responsible for the discovery of new ingredients and new applications of those already known. It is adding incessantly to the list, which surprises by the diversity of its components. As a result of the Great War, the government set aside one million pounds sterling for the encouragement of industrial research, and in 1919, the British Association of Research for the Cocoa, Chocolate, Sugar Confectionery, and Jam Trades was instituted. This organisation not only deals with the many technical problems of the industry, but provides exceedingly valuable knowledge of the properties and idiosyncrasies of raw materials, and suggestions for their most advantageous use. Bacteriological, physical, and chemical

problems constantly present themselves for consideration and solution in the production of chocolate and confectionery. In addition to this external research organisation, each modern factory possesses its own chemists and well-equipped laboratories so that every process of manufacture is subject to constant scientific control, regulating temperature, humidity, viscosity, texture, specific gravity, inversion, hydrogen-ion concentration, and general analytical control. This rigid supervision is not relaxed until the goods are delivered to the customer, and, even then, tactful suggestions are made to the consignee as to the most efficient methods of conservation so that the confections may ultimately be received by the consumer in perfect condition.

By courtesy of Messrs. A. J. Caley & Son, Ltd.

A chocolate-packing room at Norwich; illustrating the detailed supervision necessary before the product reaches the consumer.

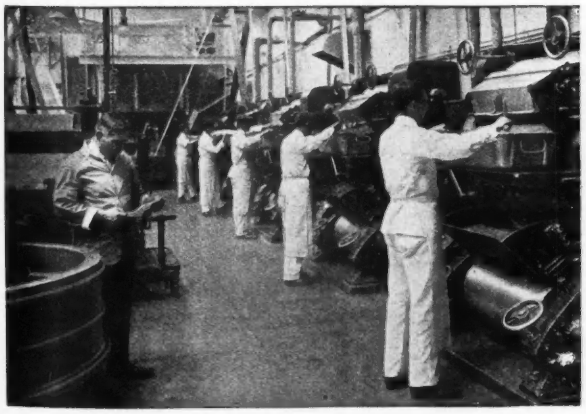
The hygroscopic character of the major raw materials used in the industry necessitates strict control of the hygrometric condition of the atmosphere immediately surrounding the work in process, as well as of the product. For confectionery purposes, the total moisture in the sugar used should not exceed one-tenth of one per cent. Every department in the modern confectionery factory is equipped with various types of humidity-measuring instruments, which are designed to indicate direct readings of humidity percentage, and with air-conditioning plant, which counteracts the inevitable variability of the atmosphere. Take, for example, the chocolate-coating department in which confectionery centres receive their mantles of chocolate. This process is carried out by means of an "enrober," a machine that is the result of extensive research on the part of confectionery machinery manufacturers in many countries. The centres are passed by an automatic feeding attachment through a curtain of temperature-controlled chocolate. It is essential that the temperature be maintained at the stipulated degree with exactitude. If the temperature of the chocolate is higher than the scientific standard for coating, separation of the cocoa-butter component occurs, giving rise to a white-spotted product; if too low, the chocolate becomes too viscous for satisfactory manipulation. From the coater, the covered confections proceed on a travelling band through a refrigerator tunnel fitted with thermometers, which record the temperature of the cooled air in the tunnel throughout its entire length. When the cooled chocolates emerge from the latter ready for packing, the hygrometer at the point of delivery must record a sufficiently low moisture content of the adjacent air, otherwise immediate condensation occurs on the surface of the sweetmeats, causing ultimate undesirable crystallisation of the sugar in the chocolate couverture.

One of the most pressing problems confronting the manufacturer of confectionery, and one that is ever-present in spite of the most determined efforts of scientific and practical research workers, is that of the premature crystallisation of sugar sweetmeats. It is perhaps possible on a laboratory scale to produce confections that will preserve their perfect character for an indefinite period, but in the factory, where mass production or high speed manufacture is the order of the day, inversion control, that is, control of the degree of crystallisation, is necessarily more difficult. In some cases, rapid crystallisation is desired, then an extremely low percentage of invert sugar is essential; in others, where premature crystallisation will destroy the character of the sweetmeat, such as chocolate-cream centres, toffees, and agar and gelatin products, controlled inversion is attained through the medium of added inversion agents. Of these, the most important is glucose, whose dextrin content is the main factor in producing a state of rigidity, hindering crystallisation in the product. Incidentally, glucose or dextrose is a natural blood sugar and is easily assimilable, hence its advantage over cane sugar when spontaneous energy is required by the consumer. Other inversion agents used extensively in the confectionery industry are "invert" sugar, a mixture of lævulose and dextrose; potassium bitartrate; and various organic acids and enzymes. The attain-

ment of a condition of equilibrium in the ultimate product is essentially a problem for scientific control. For instance, the amount of "invert sugar" which should be included in the formulæ of toffees and caramels varies from 5 to 10 per cent. according to the amount of condensed milk used (the latter itself contains approximately 40 per cent. sucrose), the amount of invert being in adverse ratio to the amount of milk present.

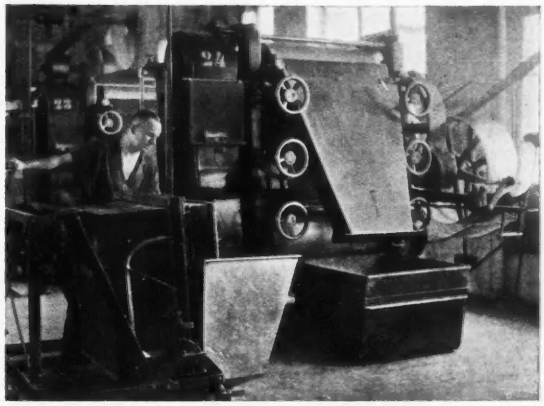
The problem of the prevention of excessive sugar crystallisation and hygrometric dissolution in boiled sugar candies requires particular attention from the practical confectioner and the chemist. First, the ratio of the sugar and glucose, of which these sweetmeats are entirely composed, must be correct according to predetermined standards, then the ultimate moisture content should be as near as possible to 1 per cent. The latter condition is attained by boiling the sugar-glucose syrup *in vacuo*. No less important for the perfect conservation of these products are the conditions under which they are packed and stored.

The manufacturer who requires uniformity in his finished products must know the chemical and physical analysis of every parcel of raw materials he purchases, as the slightest deviation in quality makes all the difference between a stable and unstable product. The fact that British refiners produce thirty grades of white sugar and ten grades of brown sugar gives an insight into the complications arising in confectionery manufacture, for these grades cannot be used indiscriminately, and it is only by the closest co-operation between the practical confectioner and the works chemist that successful production can be assured. Disinterested observers are agreed that Great Britain stands ahead of all countries in its variety and originality of confectionery products ; a happy state of affairs chiefly due to the prolific experimentation and research work.



[*By courtesy of Messrs. Cadbury Brothers, Ltd.*

Chocolate grinding machinery at Bournville.



[*By courtesy of Messrs. A. J. Caley & Son, Ltd.*

Chocolate refiner at work. With the photograph below this picture gives an idea of the massive machinery required to produce modern sweetmeats.

The annual consumption of sugar by the confectionery and chocolate industry in Great Britain alone amounts to approximately 500,000 tons, and the imports of cocoa beans for the four months ending April, 1935 amounted to 1,158,711 cwts. to the value of £1,378,128, figures that serve to indicate the enormous quantities of chocolate and confectionery products manufactured in this country, and the economic value of the industry as a whole.

Salt Radium.

THE latest application of the atomic bombardment of materials by high voltage electricity is due to Professor ERNEST LAWRENCE, of the University of California, who claims that by this method he will soon be able to produce artificial radium from common salt, capable of emitting only the gamma rays used for cancer treatment. This claim was made before a meeting of the American Chemical Society at San Francisco last month, when it was further stated by Professor Lawrence that whereas natural radium had a half-period of about 1,700 years, losing its intensity by half during that period, salt radium had a half-period of about 15 hours. Salt radium could therefore be safely injected into the tissues of a person, as it would be spontaneously destroyed in a few hours. The cost of the new substance is estimated to be less than that of natural radium, and if the experiment holds any hope in successfully dealing with the scourge of cancer, then its development will no doubt be pursued with all haste.

Improving the Sound Film.

S. R. Eade, A.M.I.E.E.

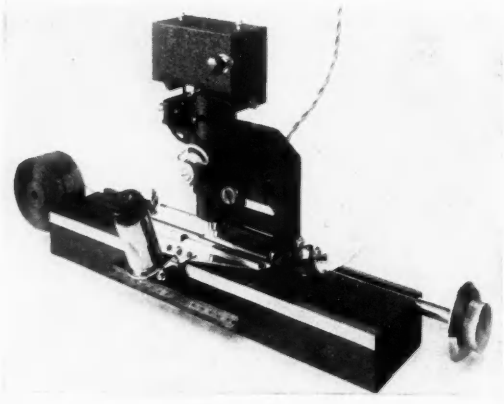
British Thomson-Houston Research Laboratory.

Dazzled, perhaps, by the brilliance of the modern sound-film, we have been too ready to forget the researches of the engineer by which it has attained its technical efficiency. The present article describes a method of determining the constancy of sound-film motion recently developed at Rugby.

ONE of the most difficult problems confronting the motion picture engineer since the advent of sound in the cinema has been to design and build mechanism which will ensure the necessary constancy of motion of cinematographic film in recorders, reproducers, printers, and associated apparatus. This problem has been made even more difficult by the lack of suitable methods and apparatus of sufficient precision to allow quantitative measurements to be made during experimental and development work. For this reason it has been usual to regard the ear as the only satisfactory means of determining the success of any particular design. An aural test in which standing waves are developed in a long narrow room, with the observer at a considerable distance from the sound source, is considerably used and has proved to be a particularly sensitive test.

In the design of continuous optical reduction-printers the problem is even more difficult owing to the necessity for propelling two separate films with great constancy at their correct relative speeds. During recent work of this nature carried out in the research laboratory of the British Thomson-Houston Co., Ltd, two interesting methods of measurement have been evolved and a description of the methods and apparatus may prove of interest to other workers in this field

It is not proposed to discuss here the design of constant-motion film-driving mechanism, but it may be mentioned that in general it is the modern practice to propel the film initially by means of a sprocket whose teeth engage the film perforations, this sprocket being driven from the remainder of the mechanism through a mechanical filter-system to absorb irregularities in the drive due to gears, chains, and the like: The motion imparted to the film by the sprocket is not sufficiently constant for our purpose owing to the fact that film shrinks irregularly and the pitch of the sprocket teeth cannot be made to fit exactly the pitch of the film perforations for more than a very short period in the life of any film It becomes necessary, therefore, to include a second mechanical filter-system before or at the recording or reproducing point to take care both of this irregularity and of irregularities introduced by the slight manufacturing tolerances which must be allowed on the various parts of the mechanical system. To emphasise the nature of this work, it may be stated that displacements of 0.001 in. are of great importance and in modern apparatus the motion of the film is held constant to within limits of ±0.0001 in. of its correct position at any instant.



Micro-densitometer for analysing sound track.

In the testing method to be described, the first apparatus to be considered is the 35 mm. sound-recording camera. This was checked by actually recording in the camera a length of constant frequency track of, say, 2,000 cycles per second, the audio frequency signal being obtained from a sub-standard oscillator of proved accuracy. The recorded track was then analysed by means of the micro-densitometer shown herewith. This instrument, which was designed for the purpose, consists essentially of an optical system and illuminant to throw a scanning beam upon the track, and a micrometer-propelled table to carry the film beneath the scanning beam. This table is mounted on ball-bearing slides and it is possible to measure the table position accurately to one ten-thousandth part of an inch. The scanning beam passing through the track falls upon a photo-sensitive cell, the current through which is arranged to deflect a mirror-type suspension galvanometer, with an effective scale length of two metres. The current of the scanning source is also measured by a galvanometer of equal accuracy and maintained constant by a slide wire.

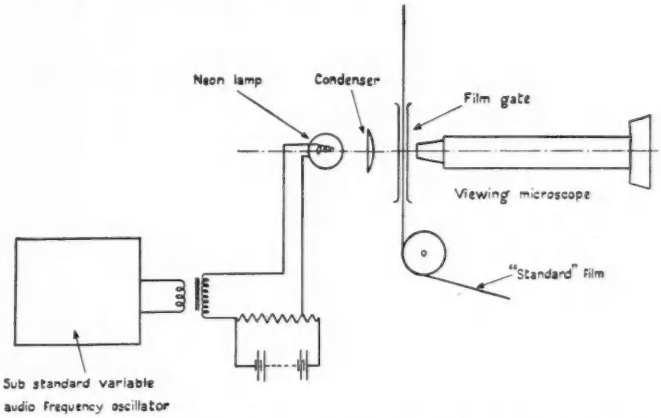
By means of this apparatus it is possible to make measurements of track density to within one part in

a thousand or, as in the present case, to measure the wavelengths of successive cycles of a constant frequency note recorded on the track. In this way, the accuracy of motion of the recording camera was checked and some lengths of constant frequency film of known accuracy were obtained. This film was also checked by the more usual method of "fold back," as the accurate checking of long lengths by the densitometer becomes a laborious process.

This "standard" film was then used to check the motion of other apparatus by a stroboscopic method. The film was propelled through the mechanism in the usual way and at the inspection point a neon lamp was rigidly fixed behind the film and a viewing microscope in front. The neon lamp was illuminated for short periods at a frequency equal to that of the note recorded upon the standard film, and thus an apparently stationary image of the track was seen, any inconstancy in the film propulsion being evident as a movement of the image.

The circuit used to excite the neon lamp is shown in the diagram above. It will be seen that the initial source is an audio-frequency oscillator. This was a sub-standard instrument of known constancy. Its output of about three watts was stepped up, by means of the transformer shown, to give an R.M.S. voltage of about 80. The output of this transformer was taken to the neon lamp with a D.C. source of about 40 volts in series. The lamp was thus illuminated once each cycle and the time of illumination could be varied by changing the ratio of the audio-frequency voltage and the D.C. biasing source. The film area scanned was 0.1 in. square.

By means of this apparatus it has been found possible to make quick and accurate investigations on all matters relating to continuous film propulsion, the method being sufficiently accurate to bring to light various troubles which were barely perceptible to a trained observer on the usual listening test. In the case of comparatively fast disturbances such as sprocket-tooth ripple, it has been found useful to run the apparatus at well below its usual speed and to employ a standard film having a recorded frequency considerably higher (e.g., ten times) than the frequency of disturbance under investigation. This can be used as a first approximation, as any disturbance will be more easily noticed, but the test must afterwards be made at normal speed to permit the correct operation of mechanical filters, etc. At normal speed such disturbances as sprocket ripple will be evident as a lack of definition in the image.



Arrangement of apparatus for stroboscopic examination of film-driving apparatus.

The Congress of Entomology.

Dr. Malcolm Burr has recently returned from the Sixth International Congress of Entomology at Madrid, and the following is an extract from his report, published at greater length in *The Times*.

It is nearly sixty years since the President, Don Ignacio Bolivas, published his first monograph on *Iberian Orthoptera*, and the entomologists of the world gathered to do honour to their *doyen*, who fulfilled his presidential functions with exemplary vigour. Spain, also, rose to the occasion in a manner worthy of her tradition of hospitality.

Among the purely technical work, outstanding was the lecture by Dr. Uvarov, of the Imperial Bureau of Entomology, on the international alliance against the locust, inspired by him and centred in London. People in a sheltered island have little realisation of the significance of this plague of Egypt. Because a few years ago the river Niger flooded its banks, a set of conditions arose which let loose a plague of locusts, which in a few years spread over nearly the whole African continent. Dr. Uvarov realised that only international action would avail, with the result that it may be claimed that the curse is almost under control. In recognition of the international value of his work Uvarov was honoured by the University of Madrid with the degree of Doctor *honoris causa*.

Dr. Jeannel, of Paris, gave an account of his researches in the insect fauna of the caves of Europe; Dr. Goldschmidt, of Berlin, illustrated the use of insects in the investigation of the determination of sex. M. Metalikov, of the Pasteur Institute, described his method of insect destruction by infecting them with tuberculosis. Señor Escalera described a new design of hive, with a method of draining honey from the comb without the wasteful destruction of larval bees, hitherto regarded as unavoidable.

Berlin is announced as the venue of the next congress, in 1938.

Electric Traction Developments.

MUCH interest has been taken in the working of the main line electrification of the Hungarian State Railways on account of the novel features of the system devised by the late Kalman de Kandó which have been adopted. The trolley wire is fed at 16 kV, single-phase, at the standard frequency of 50 cycles, from a national three-phase transmission grid which supplies energy for industrial as well as traction purposes.

The original contracts were placed in April, 1931, and the first passenger locomotive began its trials on May 6th, 1932. It was put into regular passenger service on September 12th, 1932, and within twelve months from this date it ran 86,048 miles. The second passenger locomotive began its trials on June 17th, 1932, and the two freight locomotives followed in quick succession. Satisfactory results having been obtained from the service tests of the first four locomotives, work on a further 22 locomotives was begun in April, 1933, and completed in April, 1935.

The freight locomotives were designed to haul considerably heavier trains than the passenger locomotives and at reduced speeds, but after experience in service it was decided that the further 22 locomotives should all be of the passenger type, the freight trains being correspondingly reduced in weight. The adoption of a single type of locomotive for all kinds of service has been found very helpful in simplifying the arrangements of timetables, as well as in other ways, and all the traffic on the Vienna line from Budapest as far as Hegyeshalom (117 miles W.), except for a few local trains, is now hauled electrically.

The locomotives have been uniformly reliable, even although under the care of fresh and comparatively untrained personnel. Phase changers and automatic regulators have worked perfectly without giving rise to any difficulties whatever. The phase converter is usually regarded as the most complicated part of the locomotive, so it is noteworthy that on locomotive V40,002 the phase converter has up to now completed 205,500 miles of uninterrupted service without giving the slightest trouble and without necessity of maintenance.

At the same time interesting transport developments are taking place in Italy. The Florence-Rome and Rome-Naples main lines became electric on October 28th, with accelerated services. On the Rome-Ostia line a service with a reversible train has been inaugurated, and several factories in Italy are working on special types of trolley-buses. The old Superga funicular line, outside Turin, has been replaced by a tramway line with the new tooth system, which has a capacity of 600 passengers per hour. The line has running rails and rack with a third rail to carry electrical energy. The rolling-stock includes two four-bogie cars with four motors of 100 h.p. each and with a carrying capacity

Kandó system passenger locomotive hauling 600-ton train on the Hungarian State Railway.

of 70 passengers; each car can haul two trailer cars, forming a train which, when full of passengers, weighs about 60 tons. All the cars have three systems of brakes: electric, automatic, and safety. The rolling-stock of the electric ropeway from Trieste to Opcina has been renewed with a view to shortening the trip and thus encouraging visitors to admire the view of Trieste from the hills. The Government has decided to grant an extraordinary subsidy to the company operating the railway round Etna, which facilitates excursions from Catania to the top of the volcano. This line is to be electrified in the hope that its operation may become remunerative.

A New Paint Spraying Gun.

THE superiority of spray painting over the more old-fashioned brush methods is now generally accepted. Spray painting is four to five times faster than brushing, and two coats sprayed are equal to three coats applied with a brush. No other single industrial process has so increased the output of finished products and at the same time effected such marked economies. Of recent years spraying equipment has been greatly improved, and special outfits have been adapted to suit practically every requirement from a small set for artists' use to large multi-gun sets for painting factories, bridges, etc.

A new power-driven spray painting outfit which can be carried about by hand and can be run from an ordinary lighting socket has recently been produced. It is capable of handling cellulose lacquers, paints, distempers, etc., with excellent results, and is ideal for interior decoration work or for finishing manufactured articles.

Electric Fishes.

By M. Besnard.

Assistant Director of the Aquarium of the Colonial Museum, Paris.

The following article, adapted from a paper presented at the meeting of the Second Section of the Committee of the Société Francaise des Electriciens earlier this year, describes the mechanism of the electric organs which have been specially developed in certain fish. It will be seen that certain outstanding problems remain to be solved.

THE fact that electrical phenomena are displayed by living tissue, whether animal or vegetable, is well known. Very feeble currents are produced when the cells composing the tissue come into action and during the period of their activity. These currents are specially noticeable and have been particularly studied in the case of the muscle, the eye, the nerves and the glands. Even after the death of an organism and after removal of the tissue, electric currents manifest themselves in it under the influence of various kinds of excitation up to the time when decomposition sets in.

The surprising thing is, therefore, not that there are electric fishes, but that it is only amongst the fishes that species are found which have turned the possibility of making use of electricity to their advantage. With the electric force at its disposal, a creature possesses an unquestionable security and becomes formidable to the most powerful of its enemies. It is, therefore, astonishing that amongst the incalculable number of species of living creatures only five classes of fishes should be endowed with electrogenic organs, while in only three of these are they powerful enough to be of real service to the possessor.

Adaptation of Normal Organs

The electrogenic organ in its origin is always a derivative or modification of an organ, or rather of a pre-existing tissue, and is never a specially created organ. In one case, the electric silure (*Malopterurus electricus*), it is the cutaneous glands which are modified and transformed. In the other cases, it is the muscles which have been modified and have given rise to the electric organs. The organ itself in an adult fish has already undergone such modifications that in its anatomical and histological structure it has no apparent resemblance to that from which it originated. However, amongst certain fishes with feeble electric organs—the rays for example—traces of the transition in the periphery of the organ of the normal muscular cells into the electrogenic organs can be observed.

There are about 50 species of fish with electric organs. Most of these have only feeble batteries, the use of which apparently has no other effect than to make the animal if not dangerous, at least unpleasant to the creatures which might attack it. These species are all grouped in two families, the rays and the mormyrides, an African family of fresh water fishes. The three kinds of fishes with powerful discharges are much more interesting; they are the torpedoes, a highly specialised aberrant branch of the rays, two species of gymnotus, and the malopterurus, belonging to the family of silurians.

A very curious detail, so far unexplained, is that none of the electric fishes is sensitive to the electric current. Their own discharges and those of other fishes placed near them produce no reaction in them whatever.

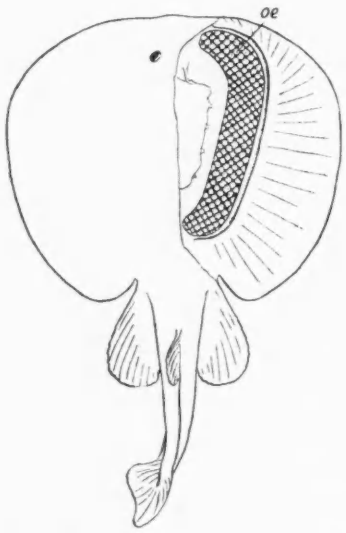
The Electric Torpedo

The best known electric fish is undoubtedly the torpedo, represented by many species found in the oceans of both hemispheres; some are common on the European seaboard. The torpedoes of our shores (*Torpedo marmorata* Risso, and some other species), are flat fishes of considerable size, like all the rays, and somewhat like a violin in shape. Normally, their length varies from one to two feet and rarely attains three feet. However, on the Atlantic coast of America there is a species more than four and a half feet in length which is dangerous to man. The body of the torpedo is covered with a soft and sticky skin without scales or prickles; its colour is neutral, varying from a dirty marbled grey to an olive brown. In the thick part of the body, on both sides of the head and at the beginning of the vertebral column, immediately beneath the skin, are the two batteries or electric organs. As already indicated, these organs are muscular complexes belonging in this case to the visceral muscle, but greatly modified. Control of the organ is assured by many large nerves leading from a special brain-centre known as the electric lobe. The organ as a whole resembles a beehive, for the electrogenic units or elements are grouped in batteries of prismatic form which number 940 for the two batteries. Each prism in its turn combines about 2,000 elements, giving a total number of about 1,880,000 units. The current is directed through the body of the fish from the dorsal to the abdominal side.

The torpedo is a deep water fish which for the greater part of the time remains motionless, half buried in the sand or ooze, awaiting its prey. Having selected its

victim, when the latter is near enough the torpedo produces a discharge which either kills or paralyses it.

The most powerful of the electric fishes is without doubt the gymnotus or electric eel (*Electrophorus electricus*). It lives in fresh water in the tropical part of South America. It has nothing in common with the eel except its shape, being long and supple and swimming in a manner peculiar to itself. The average length of adults is from three to four and a half feet. The skin is bare, of a lovely velvety black, tending slightly towards red ; the underside of the head and the stomach are brick red. The anatomy is very curious by reason of the extraordinary size of the electric organs, which occupy nearly three-quarters of the volume of the body. To accommodate these great masses all the other internal organs are located near the region of the head, and in part, are actually contained therein. On each side of the medial plane of the body are two batteries, the dorsal being very strong and occupying almost the entire length of the body. The other is weaker and thinner ; it runs the length of the base of the back fin but does not extend as far as the tail. The fine structure of the organ is based on the same principle as that of the torpedo, except that the batteries do not take the shape of prisms but rather of lamina, in number varying from 5,000 to 8,000 for the four batteries together ; the number of units of which they are made up is not certainly known.



Torpedo marmorata, *upper side. The skin and part of the muscles on the right side have been removed to show the electric organ* oe.

Study of the direction of the currents is more complicated than in the case of the torpedo. It seems that there are two principal directions, one as in the torpedo, rising in the body and falling to the surface ; the other going from tail to head in the organ and in the opposite direction outside the body. The electromotive force that can be produced by the gymnotus may be very high, reaching, for an adult specimen of average length, more than 300 V in open circuit and 17 V in closed circuit, giving as a mean 7 A.

The discovery of this remarkable creature was due to the French astonomer Richer, who, returning to Paris in 1678 from a voyage to South America, gave the first description of the gymnotus and the phenomena which characterise it. At first his account was not taken seriously. Later many scientists studied the electric eel, Humboldt's investigations having been among the most thorough.

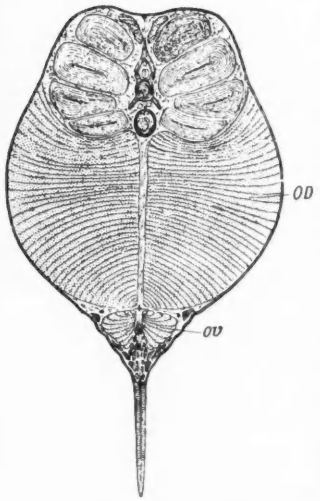
In its native habitat the gymnotus is much feared by the natives, who call it the *trembladore*. A swimmer who has disturbed one of these fishes, or has been attacked by it for any reason, runs serious risk of drowning, for a general disturbance is followed by fainting and local effects, including lasting and painful tetanic cramp in the limbs. A ford infested with the gymnotus is so dangerous to mules and horses that it is often necessary to give up the use of these animals for the time being. Even the alligators carefully avoid such localities. The flesh of the gymnotus, consisting as it does almost entirely of electric organs, is mucilaginous and tasteless, and is little appreciated as food. The natives, however, regard its fat as possessing therapeutic virtues.

The animal uses its powerful batteries for both defence and attack. When it is itself attacked or disturbed it waits till the last moment and only provokes the discharge when the aggressor is well within its electric field. Its habits are on the whole nocturnal. Swimming slowly and with scarcely a ripple, it seeks little-frequented localities. Having found a school of small fishes it approaches and, giving a number of discharges, it kills or seriously injures everything alive within a volume of water of 10 to 20 m^3. As it can obviously consume only a small part of this prey, the gymnotus must be regarded as an essentially destructive fish which quickly depopulates the waters where it is found.

When a gymnotus attempts to catch a fish or a frog without a preliminary discharge it proceeds to kill the animal in a very singular way. Holding its prey in its mouth it brings round its tail in a circle and, on touching the object with it, it establishes a circuit through its body. This action reveals a curious fact. In exciting one of the four batteries or in grouping them for the discharge, at will, the gymnotus proceeds to the electrocution by means of small doses and stops as soon as its prey becomes rigid and motionless. The explanation of this behaviour is very simple. The eel is very economical in the use of its energy. This economy, which might seem strange in a creature which makes its own current, is due to an instinctive fear that it might exhaust its batteries—which, indeed, discharge themselves

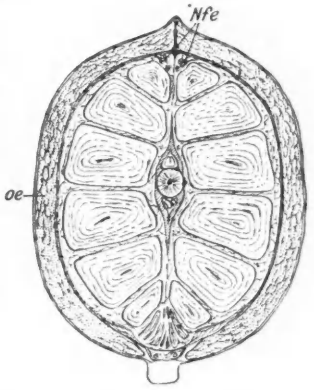
very quickly—and remain defenceless during the period required for recharging; this varies, according to the condition and vigour of the eel, from 20 minutes to an hour. In man, the discharges of the gymnotus, received directly or through water or any other conductor, produce an effect much more lasting and painful than a shock caused by an electric machine; this is due probably to the frequency and the duration of the periods of discharge of the gymnotus and other electric fishes, which correspond to the tetanic frequency of the muscular contractions of man and the other vertebrates.

The last of the electric fishes with which we are concerned is the electric silure (*Malopterurus electricus*) that lives in fresh water in Africa. It rarely exceeds 15 inches in length and is very heavy-looking, with an almost cylindrical body, a mouth surrounded with barbels, and a soft and pliant skin of a grey-brown marbled colour. This electric fish should be placed somewhat apart from the others as its electrogenic organ is not of muscular origin but purely cutaneous, arising from modified glands which are multiplied to such an extent that the whole skin of the animal from head to tip of tail has a thickness of $\frac{1}{4}$ to $\frac{3}{8}$ inch and envelopes the body like an elastic corset.



Cross section of Gymnotus electricus. OD, *dorsal electric organ;* ov, *ventral electric organ.*

The entire thickness of the skin is riddled with bunches of units or elements which are bedded in the conjunctive tissues. These bunches have an action similar to that of the batteries. The principle of the unit structure is always the same. Their disposition is, however, less rigid. These units are in the shape of lenses or small boxes with gelatinous contents, to which the nerve fibres are attached. A curious feature is that the entire innervation of the electric organ depends upon a single ganglionary cell in the medulla. This cell is very large, being indeed the largest ganglionary cell known. A powerful nerve leading from the cell goes towards the back following the medial dorsal line of the fish beneath the electric organ. From this main nerve the nerve fibres enter the thickness of the skin going towards the bunches and units. The tension produced by this organ may reach 200 V in the initial discharges. The periodicity is approximately the same as in the other cases; but, by reason of the simplicity of the nervous apparatus which controls it, its action is much more flexible. According to some authorities there are no separate discharges, these taking place only by series of 100 to 300 according to conditions. After 300 discharges the organ is exhausted, but recharging seems to take place more rapidly than in the case of the torpedoes and eels. The silure does not appear to use its electric organ for any purpose other than defence.



Cross section of Malopterurus electricus. Nfe, *electric nerve;* oe, *electric organ.*

Electric phenomena amongst fishes have been studied by numerous investigators, particularly between 1870 and 1890. There are still some obscure points, especially in regard to the electrochemical aspect of the matter. Many physiological and physical experiments that could be made are rendered very difficult by the fact that the animal lives in a conducting medium and that when it is withdrawn its physiological processes are interrupted; in any case, the biological co-ordination is broken and the result of the experiment is uncertain.

Correspondence.

CATS AND CATMINT.

To the Editor of DISCOVERY.

SIR,

I was very interested to read, in the September issue of *Discovery*, about cats and *Nepeta Mussini*. I cannot throw any light on that, but I can add a little to the problem. On two occasions I have had a cat (not the same one) burrowing into a coat pocket after a handkerchief scented with lavender water. When withdrawn from the pocket, the animal was sucking the handkerchief vigorously, with closed eyes and an ecstatic expression. I wonder if anyone can explain that.

In the botany books, the plant Valerian is said to have an intoxicating effect upon cats, but I have never seen an example of this.

Yours faithfully,

HILDA RICHMOND.

Crossgates, Leeds.

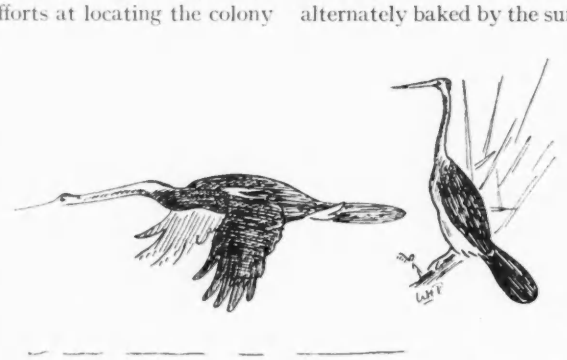
Snake-Birds of Antioch.

By W. H. Payn, M.B.O.U.

The discovery by Canon Tristram of a colony of darters on the Lake of Antioch in Syria was especially remarkable, as many hundreds of miles separate the birds from the nearest of their kind, who inhabit Northern Central Africa. It is good to learn that subsequent events have left this unique bird-group undisturbed and flourishing.

RATHER more than fifty years ago, a colony of Darters or Snakebirds (*Anhinga rufa Chantrei*) was found by Tristram to be breeding on the great Lake of Antioch in Northern Syria. Since then the colony had not been visited again by European ornithologists until we went there in the spring of last year. The lake, north-east of the ancient city of Antioch, is some fifteen miles by twelve in area, with its entire circumference fringed by a belt of reeds which in places reaches a width of nearly two miles.

With such a large area to explore, it is not perhaps surprising that at first our efforts at locating the colony —for we had no idea of its situation, if indeed it still existed—met with singularly little success. The various fishermen interviewed were not very helpful, as their ideas as to what constituted a bird with a head and neck like a snake, ranged between a cormorant (not a bad shot) and a tufted duck (a singularly poor one).



Typical positions of the Snake-bird or Darter (Anhinga rufa Chantrei), *in flight and at rest.*

At last, however, when we had almost decided that the darter colony no longer existed, we discovered, living alone on a little round-topped island among the reeds, a fisherman who professed to know not only the birds themselves, but also where they bred, and his description of them being reasonably accurate it was with high hopes that we embarked, early one morning, in his narrow flat-bottomed punt and pushed off into the wilderness of reeds that girdled the shore.

At first our progress down the narrow waterways which the fishermen keep clear of reeds was delightfully easy and rapid, but gradually the channels became narrower and more overgrown, till at length they ceased altogether and we were left to plough our own way through the reed beds. Here we seemed in a world apart, with the feathery tops of the reeds whispering and swaying more than ten feet above our heads and no sound but the loud chattering of colonies of great reed warblers, the "pink, pink" of bearded tits, and the lapping of the water beneath the boat. From time to time the monotony of our progress was relieved by our emergence on to little patches of open water, where life was more abundant. Water tortoises, whose shells were so thickly grown with weed that it was remarkable they were able to swim at all, lay basking on the lily pads, whence they hastily scuffled into the water at our approach; purple gallinules groaned in apparent anguish among the rushes; while overhead marsh harriers beat restlessly back and forth, ever on the watch for some unwary moorhen chick or duckling.

After an hour's travelling, during which we were alternately baked by the sun, cramped by the narrowness of the punt and the danger of movement in it, and damped by the bilge-water which soaked through the bundles of green rushes upon which we were sitting, we suddenly emerged on a large sheet of open water, several hundreds of acres in extent, upon the glassy surface of which many lesser cormorant and a small party of red-crested pochard were swimming. A strong breeze blowing across the lake, from which this sheet of water was separated by only a fringe of reeds, raised waves large enough to set our frail punt rocking unpleasantly, but we were reassured by the calm attitude of the boatman who, balancing bare-footed in the stern, continued on his way unperturbed, driving us forward with powerful strokes of his long pole. When about half-way across the open water, as we were busy watching the parties of cormorant through the binoculars and at the same time trying to keep the boat on an even keel, the boatman suddenly called our attention to an object which had appeared above the waves some distance ahead. The glasses, when brought to bear, revealed it as a small narrow head on a long and extremely thin neck which rose straight up like a periscope from the water.

Having studied us at its leisure for a while, the little head sank quietly out of sight, but next moment, amid a flurry of spray, a great black bird appeared, flying straight out of the water, flapped heavily along the

surface for a few yards and then, rapidly gaining speed and altitude, disappeared from sight over the reeds. A bird as large as a goose, with neck in length out of all proportion to its size, wide fanned tail and great ragged wings gleaming with moisture—such was our first view of the snake-bird. Soon, along with ever increasing numbers of pigmy cormorant, more darters began to appear, flying high in the air when outward bound, but when returning to the colony laden with fish, travelling only just above the surface of the water. Though they were similar in colouring and general appearance, we soon learnt to distinguish the darter from the cormorant on account of the former's longer tail and the kink in its neck, which in flight was held at a distinct downward angle from the rest of the body.

We were now rapidly approaching the reeds on the opposite side, and already the situation of the darter colony was apparent, for many of the great birds, as well as the smaller cormorants, were wheeling round a bed of particularly tall reeds while others kept coming in from all parts of the lake ; and when, a few minutes later, we crept silently round the end of a spit of reeds which grew out into the open water, we had our first close view of the busy life of the colony. On a great raft of floating vegetation sat a dozen or more darters, bolt upright, with necks stretched to their full extent and wings hanging open in typical cormorant fashion ; close by other darters and several cormorants were preening and bathing, while, as if to complete the picture, balancing on the tall reeds in the background were snowy egrets and squacco herons, some carrying pieces of nesting material in their bills.

The nests, with dirty chalk-coloured eggs, are built close together.

The nestlings, covered with whitish down, defend themselves valiantly when approached.

For a moment the surprise of our sudden appearance held them all motionless, but quickly the spell was broken and with squawks of alarm the herons dropped their pieces of reed and flapped hurriedly away, while the cormorants disappeared silently into the dark water The darters, cut off from the open water to which this narrow channel was the only exit, and unable to rise up straight over the reeds, were uncertain what course to follow, but finally, while one or two sought safety in the water, the majority unfurled their great sails and, half flying, half paddling, made for the open, beating past within a few yards of us and in doing so giving us a wonderful opportunity of admiring their chestnut-and-white necks and long grey scapulars.

Our attention was next attracted to a belt of tall reeds from which rose a deep murmur of voices, of grunts and gurgles and quacks which, mingled with the splashing of water and the hum of insects, seemed to fill the whole air, but this was nothing to the pandemonium which broke loose around us when the boatman turned the punt and sent its sharp prow crashing into the reed-bed. On all sides hundreds of darters and cormorants rose clamouring from their nests, while the air throbbed with the beat of countless wings to which was added the shrieks of the old birds and the hungry squeaks of the nestlings. At first we could do nothing but balance in the wobbling punt and gaze spellbound ; but gradually, as the hubbub began to subside, our

faculties returned and we were able to observe with a certain amount of clearness. All around us in the reeds were nests, nests, and still more nests, some containing young darters and cormorants in varying stages of growth, while the majority still held the dirty chalk-coloured eggs of both—indistinguishable except in size—and here and there, by way of contrast, were the small blue eggs of the herons and the deep blue-green eggs of the glossy ibis ; and over all hung the unspeakable smell of decaying fish.

Overhead the air was black with the parent birds. Cormorants and herons flapped past within a few yards or clung awkwardly to the tops of the reeds, while the slower-flying darters which resembled, with their ghoulish appearance and ragged black wings, some kind of evil genii, sailed to and fro at a safe distance.

The nests, built of reed flowers and dead rushes, were slung haphazard among the reeds, some closely packed together in groups, others ranged in tiers with as many as four nests one above the other, all of them so substantially built and so firmly attached to the reeds that they would almost support our weight. We could not help being struck by the resemblance, in dirt, untidiness, and overcrowding, of this great bird colony to some of our worst tenements in slumland, though here, at any rate, there appeared to be no sign of sickness or disease.

The nestling darters were ugly little creatures, with long, square-tipped bills and kitten eyes and covered all over with whitish down ; long before they were fledged they could swim and dive with ease and it was amusing to see a whole nestful of little woolly darters tumble pell-mell into the water at our approach and disappear, to study us from a safe distance with only their heads above water. Those too young to seek safety by diving defended themselves valiantly when handled, drawing in their necks and shooting them out again with lightning speed, striking for our faces. The fledgling darters were dusky brown in colour, but we saw little of them, as the majority had retired into deep water at our approach.

All the nestlings appeared to feel the intense heat acutely, the little naked black cormorants in particular crouching with quivering chin-pouches, and from what we could observe—both at this and at other bird colonies we visited—it appears that one or other of the parent birds remains continually at the nest to shield the young with its own wings and body from the rays of the sun.

Surrounded by the wonders of this great metropolis, we had completely lost all count of time, but now our thoughts were recalled to earth by the boatman who intimated that it was already long past mid-day, that we were far from home and, most important of all, that the wind was rising steadily and would soon make it unsafe to cross the open water in our light punt. To all of which arguments the "inner man," already ignored overlong, added his voice ; so, settling ourselves as comfortably as possible in two inches of bilge-water, we regretfully bade farewell to the snake-birds and turned to battle with the rising waters of the lake.

The Story of the Lamp.

By F. W. Robins, F.R.G.S.

The control of illumination was among the first advances that raised Man above the rest of the animal world. How the Lamp developed from the primitive firebrand makes a fascinating tale of progress through the ages.

WHEN man first found the way to make a fire, he made the most momentous discovery of the world's history. Without it none of our modern scientific achievements would have been possible.

One of the many stories that start with the making of fire is that of lighting. Man's first light in the hours of darkness was the light of the fire, and, in the form of beacon, fire basket, and cresset, it retained a place in the history of lighting until comparatively recent times. The second stage was, in essence, the removal of a part of the fire to form a handy portable light. This was the torch in its simplest and earliest form, a brand plucked from the fire. The torch was the predecessor, but not the ancestor of the lamp. Its direct descendant was the candle, which came into being by a gradual process of reducing the core and increasing the combustible coating of the developed torch—a construction of resinous wood or fibrous material coated with pitch, grease, or wax.

Just as the history of artificial lighting can be divided into the story of the lamp and the story of the candle, so does the history of the lamp itself start from two points, but in this case the lines of development converge at a very early stage.

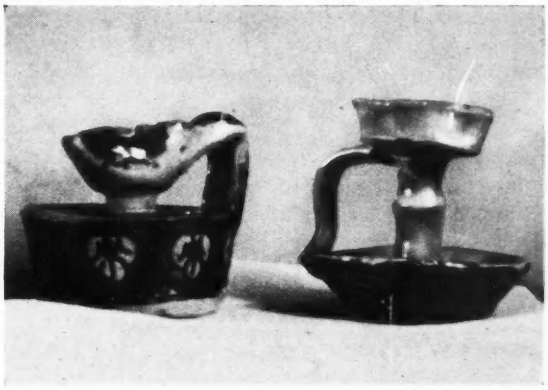
The use of a receptacle for grease or oil in liquid form with a wick immersed in or floating on it, so far as is known at present, dates, in Europe, from the Late Palæolithic period, and the earliest lamp takes the form of a hollowed-out stone. It is a reasonable assumption that the idea was the result of observation

when a piece of some fibrous material fell into a pool of grease in a natural hollow and caught fire. Anyhow, the earliest examples of stone lamps are crude in form and very little removed from the natural stone with a hollow in it. Later, a more or less square form is adopted and this is apparent both in the much later stone lamp from Wookey and in the chalk lamp (Transitional or Early Neolithic) from Cissbury Ring, Sussex. The writer has a stone lamp from Cornwall, which is very like the large stone lamps of the Eskimo, having one side straight, with a thin wall, and the other side curved, with a sort of platform on which the thumb comes when the lamp is held by one end. There is a groove suggesting a wick channel at the other (pointed) end. The Eskimo lamp is a multiple-wick lamp used for heating as well as lighting. Side by side with the development of a lamp technique, the primitive stone lamp seems to have survived for some thousands of years. One found at Southampton was at such a superficial level as to suggest, possibly, a period not long before the Roman invasion. Even later survival is shown by the mediæval cresset-stone, which is essentially the stone lamp and not very far removed, in some cases, from its most primitive forms. Generally speaking, these cresset stones, whether single stone bowls

Three Roman pottery lamps with relief decoration, of the 1st *century A.D.*

or groups of hollows in a stone slab, are without a wick channel of any sort and adapted only for a wick supported either by a floating disc or by an upright standing in a small hole at the bottom of the bowl.

The other root of lamp-development is also a natural object, and remained purely natural for a considerable period. That object was the sea-shell. Sir Leonard Woolley, in his excavations at Ur, has discovered not only shell-form lamps but actual shells which appear to have been used as lamps. More striking still is the fact that the National Museum of Wales at Cardiff possesses two quite modern specimens of shells used as



Pottery lamps of primitive type for olive oil and floating wick, from N. Africa (left) and S. Italy (right).

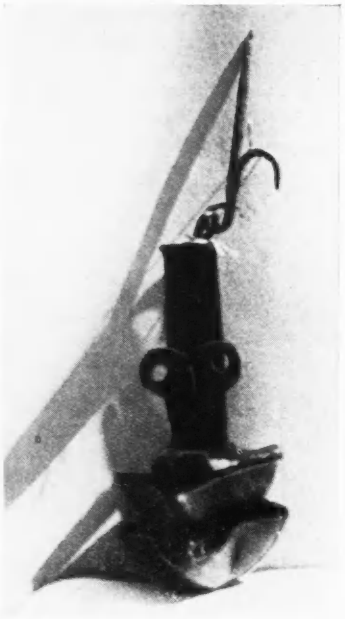
lamps (one of which, Mr. Peate tells me, was used in the Gower Peninsula as late as the middle of the 19th century) and that some of the older inhabitants of Cornwall speak of shells used as lamps within living memory. The early pottery lamps of the Ægean, Phœnicia, etc. (known to the British Museum as the "cocked-hat" type, though "shell-type" seems much more expressive, both as to shape and origin), are distinctly derived from the shell and point to an earlier use of actual shells for similar purposes. These, in some cases, date back to at least the second millennium B.C. but the design has survived in Palestine until comparatively recent times. The Egyptian lamps mentioned by Herodotus as being used with castor oil were probably round, and certain simple open earthenware lamps of Roman date, with spouts, found in the Fayoum, probably continue an earlier type.

There seems to be a hiatus in the history of the lamp between Prehellenic times and about the 6th century B.C. The early Greeks appear to have derived their artificial lighting from braziers (fed with charcoal or oil) or torches. When the lamp reappears, it is still an open one, but a continuous development sets in. The first stages are the bridging of the projecting nozzle and the recurving of the rim of the lamp. The latter is the more significant in that the process leads, first of all to the lamp with the flat rim, and gradually to the closed-in body, a stage which is reached about 400 B.C. A change has also taken place in manufacture. The early open lamps are hand-made; most of the true Greek lamps are made on the wheel. Decoration, on Greek lamps, is confined to colour and glaze until shortly before the Christian era, when ornamental design comes into fashion and lamps are made in moulds.

From an artistic point of view, the most interesting of

ancient lamps are the Roman lamps of the 1st-3rd centuries A.D. Amongst the numerous examples which have survived, there are hardly two alike (except for a plain 1st century type, principally found in the north-west of the Empire). The depressed bowl which is the feature of the Roman lamp lends itself admirably to decoration and practically every aspect of fable, mythology, and social and animal life is employed. It would have taken dozens of the ordinary single-nozzle lamps to have given much light, and for greater illumination the means employed would be the more elaborate bronze lamps, or, at least, the less common multiple-nozzle pottery lamps. Bronze lamps had appeared to a limited extent in Greek times (even, as open lamps, earlier), but it is under Roman auspices that they begin to break away from traditional forms.

After the 3rd century the artistic value of the lamp declines. Byzantine and Early Christian lamps are crudely, often unevenly, made, and the designs are more formal—frequently Christian emblems such as the Chi-Rho, the dove, the peacock, the fish, and, at a late stage, the cross itself. In the 3rd and 4th centuries, Egypt develops a very typical form of round or ovoid lamp, usually with a frog or toad design (natural, or conventionalised into the legs and head only) which is peculiar to that country.



A Scottish cruisie of last century, showing the two bowls, and the upright back strap with its swivelled hook and spike to enable the lamp to be either hung on or stuck into the wall.

Possibly the decadence of the quality of the pottery lamp may be connected in some way with the use of a new medium, glass. In the 4th century, Byzantium introduced the glass lamp of bowl, bell, or cone form, the prototype of the glass lamp to be seen in Catholic churches and in mosques to-day. Originally these were plain vessels for floating wicks but by the 5th or 6th century an improvement came into being in the form of a central stem for holding the wick upright. The Catholic Churches retain the floating wick; the Mahomedan mosques in some cases (e.g., the Grand Mosque at Algiers) have fitted their glass lamps with electric light!

Side by side with the glass lamp, however, the pottery lamps persisted, without much alteration in form, in the East. They became more globular, with a lengthened spout and a funnel to facilitate filling, and on those lines are still to be found in North Africa, though electricity is fast ousting them. Further East, in India in particular, even more primitive forms continue among the peasantry; the little earthenware ***chirags*** are indistinguishable in form from the early spouted saucer lamps of Egypt to which reference has already been made.

It is curious to note that, while pottery lamps have survived until modern times in Italy (especially in the south), the oil reservoir, mounted on a handled column, takes the form of the very early "cocked-hat" type of lamp and is completely open, with two spouts. A somewhat similar lamp from Holland has a globular closed body and a more elaborate support (e.g., a human figure) while the Spanish counterpart has a closed body and projecting spout, obviously based on Moorish influence. Similar pedestal lamps from North Africa have boat-shaped bodies partially closed in.

In Northern and Western Europe we meet the cruisie, illustrated herewith, an iron lamp in the form of an open pear-shaped bowl, usually with a second bowl beneath. It is reputed to be Celtic in origin and survived in the Orkneys and Shetlands and certain Irish islands until about sixty years ago. Several English museums have specimens amongst their "bygones" but investigation suggests that they have all come from Scotland. Tallow or fish oil was the fuel for these—the former a smelly medium that certainly encouraged outdoor life. In Cornwall it was called a "chill" (as was also a pottery lamp like the Mediterranean types) and the wick was either a textile one or a reed. In England, the candle and the rushlight held their own until the early 19th century, but the lamp itself developed to a greater extent on the Continent, where, by the 18th century, a variety of open and closed lamps (mostly the latter) had come into being, generally in brass or pewter. The Dutch, especially, developed the brass lamp, the usual form being a canister-like body with a projecting spout and a drip channel, either for

hanging or on a pedestal for standing and known by the term "dirty-nose," which is eloquent of their smoky propensities. A well known form of closed brass lamp in Italy and Spain consists of a globular body with one to four projecting burners, which slides up and down a stem on a circular base.

Whale oil replaced tallow or vegetable oil in most European countries, being displaced in its turn by benzine, colza oil (1836), and eventually paraffin (1850). The curious part of this is that, while popular opinion regards paraffin as old-fashioned compared with electric or gas lighting, actually gas lighting was invented sixty years before the advent of the paraffin lamp, while electric lighting had already been experimented with and came into the realms of practicability some ten years or so later.

The story of the lamp over something like twelve thousand years is one of gradual improvement and enclosure of a simple fuel reservoir, with a projecting or floating wick. All the real basic changes in the means of illumination have taken place within the last 150 years and even to-day primitive forms have their place—as, for instance, in the flaming oilcan of the locomotive fireman. It is evidence, too, of the set channels in which men's minds work that, in at least two examples known to the author, men at the front, in the Great War, probably knowing little or nothing of the ways of prehistoric men, fell back on the most elementary means of lighting—forming, in the one case, fish-oil lamps from sardine tins punctured to receive string wicks, and in the other, grease lamps from condensed milk tins filled with bacon fat.

Advance, Photography !

MR. JAN GORDON, art critic of the *Observer*, very justly spoke, in one of his recent articles, of "the advancing technique of the photographer" as a serious rival to the non-intellectual, i.e., the representational, school of painting. The truth of this was fully borne out at the 80th Exhibition of the Royal Photographic Society, which has just closed after a successful month. Never has the high standard which photography has now reached, both from the artistic and the technical point of view, been better brought out in a collective exhibition. And now, for those who were unable to be present at the show, a very excellent substitute is forthcoming in the shape of *The Year's Photography*, 1935-36, the official publication of the R.P.S., which is priced at 2*s.* 6*d.*, and is a very good half-crown's-worth.

It is not so long since many of us in England found it expedient to go abroad, mainly to Germany, for our high-class photographic reproductions. The seventy plates in the photographic annual now under review are a sufficient demonstration that such excursions abroad are no longer necessary. The President of the Society, Mr. Robert Chalmers, reviews the reproductions in a half-dozen concise pages, and while on the whole he appears satisfied, he does not hesitate to add a few words of mild censure where such seem due. From the non-technician's viewpoint we would single out for praise G. L. Hawkins's *Monday Morning* (Plate I), with its dynamic lines, and the landscapes *Hill Serpent* (X), by G. A. Murch, and *Cattle Tracks* (XIV), by J. B. Eaton, for their high imaginative quality. Among the architectural subjects *Albi* (VII), by J. B. Symes, is notable for its originality and *A Castle of Romance* (XXIX), by Alex. Keighley, for its appreciation of the possibilities of the subject (the Alcázar at Segovia); while among the natural history subjects—a very fine collection—the *Rock Goby* (XLII), by Douglas Wilson, stands out as a technical achievement.

Photography in Science

Dr. E. P. Davey adds an interesting section on *Science and Photography*. Among the scientific exhibits he calls our attention to some striking pictures of convection currents around water heaters, and to the studies of fuel jets made in aeronautical research.

The spectrum of the newly discovered star, Nova Herculis, has been photographed, and the further advance made during the year in sensitisers for the infra-red has enabled the solar spectrum to be recorded up to 13536Å, the present limit of infra-red photography.

Something quite new is the "Pola" screen, a filter which "polarises" light. With it, reflections can be eliminated, or the sky intensity reduced in the same way as by using a filter, because both light reflected from a smooth surface and the light from a blue sky are already polarised, and the interposition of the "Pola" screen at the proper angle cuts out this light. Most striking are the pictures of shop windows, taken with, and without, the screen. The exhibit illustrating the use of the "Avo" exposure meter is another illustration of the happy application of science to photography.

Amongst the photomicrography exhibits, that of the "Feather" in Carbro Trichrome, the "Embryo Bat" and "Podura Scale," the latter having a high magnification and very good resolution, may be mentioned.

And, necessarily, the examples shown at this Exhibition represent only a portion of the many and diverse ways in which science has been applied to photography, or photography to science.

National Trust News.

FROM time to time the National Trust has received considerable bequests both of money and of land. Sometimes such legacies come " out of the blue " ; that is to say, no previous notification has been given to the prospective recipients nor perhaps is there any trace of the benefactor having been a Member of the National Trust or in any way interested in its work. On the other hand the Committee of the Trust has been asked to express an opinion upon many bequests contemplated by generous friends who have wished to make arrangements for the disposal of their estates in what may be a very distant future. It is, of course, almost impossible to pronounce a final verdict in such cases, as circumstances might substantially alter between the time when the matter was first suggested and the time when the bequest becomes operative.

An instance of this is Blea Tarn in Westmorland. The owner, Colonel H. D. Olivier, informed the National Trust some years ago that in his will he had left the property to the nation subject to a life interest. Colonel Olivier has recently died and the place now passes to his son, so that it is likely to be a considerable time before the Trust comes into possession. In the meantime, however, there is every hope that the property will remain more or less untouched and in its present condition. Blea Tarn is well known to visitors at the Lakes. It is a small upland lake in a hollow of the ridge of fells that separate Great and Little Langdale. It was always a popular drive in the days of horse charabancs—and is still in the days of motor cars—to do the " Langdale Round," which involves taking the narrow hilly road that overlooks the tarn and actually passes the farm house. This house is a lonely spot as the nearest dwellings in either direction are about two miles away and quite out of sight. It was here that Wordsworth's " Solitary " lived, and long descriptions of the scenery are given in the " Excursion." Round about the farm buildings are a few green fields enclosed by stone walls, the tarn itself is backed by a large plantation of larch and fir, and higher still are the steep crags of Blake Rigg (a corruption of Blea Crag Ridge). To the east is Lingmoor, a comparatively low fell, partly heather-glad. To the north, across Great Langdale, where the National Trust already owns three farms, tower the twin peaks of the Langdale Pikes—Pike o' Stickle (2,323 feet) and Harrison Stickle (2,401 feet)—with the adjacent crags of Pavey Ark, a famous field for the rock-climber. To the south, across little Langdale, is Wetherlam (2,502 feet), which marks the edge of another Trust holding, the large Monk Coniston estate, bought by public subscription in 1930.

The March of Knowledge.

We propose in this column to record month by month a few of the current advances in the progress of knowledge, making as varied a selection as possible within the limits at our disposal.

RESEARCH into the possibility of curing epilepsy by snake-venom is being actively pursued at the London Zoological Society's gardens, Regent's Park, following on the discovery made by Dr. Burgess Barnett, Curator of Reptiles, in co-operation with a research worker from St. Bartholomew's Hospital, that a certain type of venom was beneficial in cases of hæmophilia. Dr. Barnett, with examples of practically every species of poisonous snake passing through his hands, is in an unrivalled position to investigate possibilities ; and he is gradually amassing a good supply of venoms with which to experiment further. The " milking " method of extracting the venom,* though dangerous, is the most satisfactory means of collecting the necessary material.

* * * *

Discovery II, the Royal Research Ship, has left England on her fourth Antarctic commission. This season's work will continue the water-testing investigations and is expected to throw new light on the life and migrations of whales and the minute floating organisms on which they feed.

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In a recent issue of *The Times*, a photograph appeared depicting the first mechanically built house in Britain. At present the building-machine, an invention of Mr. James Haigh of Leeds, is suitable for the erection of cylindrical houses only, and the resulting residences have an oddly unfamiliar air and suggest furnishing difficulties ; but the mechanical builder can be adapted, at extra cost, to the construction of the normal cubic type of house. The machine can mix and shape cement blocks and lay them quicker than a bricklayer. It can also construct floors, staircases, and flat roofs.

* * * *

Excavations during the month have brought to light a Bronze Age village in Hungary (*c.* 1000 B.C.), and, nearer home, what is believed to be the remains of a human skeleton of an age comparable with that of the Peking Man, in the Thames gravel near Gravesend. The importance of this find, it is hoped, may be equal to that of the Piltdown Man, unearthed in Sussex some thirty years ago. At Jericho, Professor Garstang reports the discovery of baked and unbaked clay statuary from a level far below that of the biblical city, showing a very high standard of artistic representation.

* *Discovery*, January, 1935, p. 6.

Our Saxon Forefathers

By Edward G. Hawke.

An adequate history of the Anglo-Saxons has long been awaited. Mr. Hodgkin and the Clarendon Press have now filled the gap in truly generous style, and the period has at last been dealt with on a scale justified by its importance.

THE appearance of a first-rate history* of our Anglo-Saxon forefathers, up to the death of Alfred, is much to be welcomed. The modern reaction against J. R. Green's once admired but quite untrustworthy histories of Saxon England has gone so far that for many years teachers and readers have fought shy of the subject. The tendency has been to dismiss the Anglo-Saxon period as an obscure age of barbarism and to begin English history with the coming of Norman William. Clearly that will not do. The Anglo-Saxons had lived here for six centuries before 1066 and formed the vast majority of the nation over whom the Normans ruled. If we are to understand our national beginnings, we cannot ignore our Saxon ancestors, however difficult their language may seem or however sparse and crabbed may be their annals. Fortunately, while the period has been generally neglected, a number of specialists have been quietly working at Anglo-Saxon art and archæology, the Anglo-Saxon dialects and literature and the early place-names, and their researches have done much to supplement the scanty literary evidence. With their help Mr. R. H. Hodgkin has produced an extremely readable and scholarly book, which should revive general interest in the early fortunes of our race.

It is characteristic of Mr. Hodgkin to take the reader into his confidence, set out fairly the opposing theories on matters of controversy and give his own opinion modestly. He uses the archæological evidence for what it is worth but recognises its limitations. Early Saxon burials suggest that the immigrants from Slesvig-Holstein penetrated into the Upper Thames valley from the Wash, besides settling on the east coast, but the absence of such burials does not necessarily contradict the legend of a Saxon invasion of Hampshire from the sea. The settlement doubtless began with the German mercenaries of Hengist and Horsa who, after taking service with Vortigern of Kent just as their kinsmen had served the Romans, turned their swords against their employer. But the Saxon colonisation of England was a slow and lengthy business in which, the author thinks, the humble pioneer who made a clearing in the forest and cultivated it played a more decisive part than the little armies whose battles are mentioned in the Chronicle. Kent, which had

Examples of Kentish chip-carving jewellery of the Anglo-Saxon period. Above, two disc-brooches; below, square-headed brooch (left) and radiated brooch (right).

By courtesy of the Oxford University Press.

**A History of the Anglo-Saxons.* By R. H. HODGKIN. (Oxford University Press. 2 vols. 30s.)

long been prosperous owing to its proximity to the Continent, was a special case. Here, the mysterious Jutes, whom Mr. Hodgkin regards rather as Saxon adventurers than as a separate tribe, may have occupied the county at one swoop. Elsewhere, the struggle with the Britons, and still more with the trackless woods, was long and difficult. The author compares it not inaptly to the colonisation of North America by the Pilgrim Fathers and the Virginians. London, he holds—and this is one of the many interesting new points in his history—may well have continued as a trading centre throughout the Early Saxon period. There are no traces of Saxon settlement at that time within thirty miles of London.

Rome and Iona.

The conversion of the Anglo-Saxons to Christianity, beginning with St. Augustine's mission in 597 and completed later on in the seventh century, is justly stressed as epoch-making. It was due partly to Rome and partly to the Celtic Church directed from Iona, and, though the two religious organisations disagreed about matters such as the tonsure and the date of Easter, each exercised a salutary influence on the young nation that was gradually being formed. In the eighth century the Anglo-Saxon Church produced Winfrith or Boniface, the apostle of Germany, and Alcuin who became Charlemagne's educational adviser, as well as the Venerable Bede. The kings, especially in Wessex, owed much to their clerical advisers, and were at pains to keep in touch with Rome. When in the second half of the ninth century the fury of the Viking invasions burst upon England, it was a Christian people that resisted the heathen.

Mr. Hodgkin's account of the invasions and of Alfred's part in saving Wessex is particularly clear and judicious. The war-bands of Northmen in their swift galleys are compared to the Elizabethan adventurers who preyed on the Spaniards. The Vikings had harried Ireland and the Frankish lands for half a century before they landed a great host in England in 865. They had the command of the sea: what is more, they were professional soldiers as compared with the English fyrd or militia who could not be kept from their fields for more than a month or two. It is not surprising that they quickly overran and conquered Northumbria, Mercia, and East Anglia; the wonder is that Wessex after thirteen years of hard fighting managed to survive. The author is surely right in attributing its success to Alfred's generalship and power of organisation and to his wisdom in not pressing the enemy too far. The Peace of Wedmore in 878, by which the Danes were to keep out of Wessex while provision was made to avoid frontier disputes, was statesmanlike in its moderation. And it gave Alfred time to fortify his frontiers in readiness for the next invasion by other war-bands. Mr. Hodgkin, in one of the many broad generalisations that lend variety and interest to this book, notes in Alfred "a certain humanity or practical sense which makes it possible to see good in an opponent and a readiness to bear or to forbear" and marks these as national traits. As with king, so with people, "moderation, compromise, respect for authority, and devotion to their kings"—these seem all ready to stand out as characteristic features of the race.

Mr. Hodgkin takes due account of the early Anglo-Saxon literature, especially of Alfred's works, and he devotes some useful pages to art and social usages. His text in this respect is subsidiary to a long and notable series of illustrations, whether in line or in half tone, and including four coloured plates of jewellery, early and late, of the sixth-century Taplow drinking horn, and of a page from the Lindisfarne Gospels. The pictures speak for themselves. Early Anglo-Saxon art at its best, in the Northumbrian crosses for example, or the ivory carvings or the illuminated MSS., was both distinctive and fascinating. Mr. Hodgkin also provides a most valuable series of new maps and learned readers will delight in the abundant notes which he relegates to the end of each volume. It may be hoped that he will now continue his admirable book through the dramatic century and a half that separated Alfred's death from the Norman Conquest.

Mr. Hodgkin is the son of the eminent author of *Italy and her Invaders*. He well maintains the historical reputation of his family.

Mapping Saxon England.

VERY appropriately, on the heels of Mr. Hodgkin's admirable work reviewed above, comes *Britain in the Dark Ages: South Sheet*, a map on the one-millionth scale, published by the Ordnance Survey, Southampton (paper, 4*s*.; mounted on linen, 5*s*.). The "antiquarian" tradition in the Survey is of old standing, but it was not until 1921 that archæology received the final official benison, with the appointment of an Officer to the Ordnance Survey for dealing with this especial study.

The map under review follows those of Roman Britain, and deals with the period A.D. 410-871, which, within half a century at either end, is the epoch covered by Hodgkin's History—essentially the age of the Anglo-Saxon colonisation and consolidation of England. The Viking element, which scarcely affected England before 865, is rightly excluded. The map, which extends north to the Clyde, is a masterpiece of clarity with well-chosen type-faces; the conventional signs for forest and marsh convey the right idea of the difficulty of the country; while those for the surviving monuments are prominent without being obtrusive. This is an indispensable document for all interested in our island story.

Micro-Organisms in Industry.

By R. S. Potter.

Though micro-organisms have been employed in certain manufactures for centuries, it is only of recent years that any systematic attempt has been made to understand their action. Mr. Potter explains some of the processes which govern the use of these beneficent bacteria.

THE popular conception of "bacteria" is vaguely something that is responsible for diseases and disorders of human beings, animals, and plants, and it is perhaps in this connection that we hear most of the so-called germs or microbes. Actually, however, there are many more known species of micro-organisms which are quite harmless to man, animals, and plants, than those which are harmful. Dr. Bergey, in his *Manual of Determinative Bacteriology*, describes 1,120 species of which 75 per cent. are non-pathogenic. It is with these non-pathogenic kinds that we are mostly concerned here, although a few pathogenic organisms have found a place in industry during recent years.

Industrial uses for micro-organisms date back to very early times, and we read of the wines and other fermented beverages of many ancient civilisations, but it is only as a result of the development of our knowledge of bacteriology that progress has been made. This science has enabled man to harness these minute organisms to perform many duties of industrial and economic importance: not only have the old industries which depended upon the activity of micro-organisms, such as brewing, wine making, and the textile industry, been placed on a sound basis, but entirely new processesses have been developed. In certain industries man has utilised micro-organisms more or less unconsciously for centuries, as for example in agriculture, and in such cases the benefits of bacteriology have been more in the direction of producing the best conditions for their development, than by the use of new types or strains. It would obviously be impossible here to give more than an outline of the various applications of micro-organisms to industry, or even to indicate all the industries which have benefited by such applications. A few typical cases will serve to show the scope and importance of the subject.

Yeast Control.

The use of yeasts for fermenting sugars and transforming them into alcohol needs no introduction, since it is the basis of brewing, distilling, cider making, and the wine industry. Fundamentally these industries are the same to-day as they have been for many years, but by employing only healthy and suitable strains of yeasts, greater uniformity and increased stability of the products have resulted. Whereas previously the resultant type of fermentation was to a certain extent a matter of luck, this is now controlled carefully either by inoculating the medium with a pure culture of a good yeast or by controlling the conditions so that only the requisite strains will develop.

Although the fermentation industries are amongst those which must be considered as some of the most important as regards the part played by micro-organisms, their establishment is so well known that it will perhaps be of more interest to pass on to some of the more recent applications of micro-organisms to industry. The beverage industry, however, affords a good example of one in which development has taken place as a result of studying the most favourable conditions for an established fermentation to proceed.

Bacilli for Explosives.

During the 20th century many processes for the production of chemicals by employing micro-organisms, have been worked out and many patents have been registered. Some of these have since become commercial successes, whilst others, although of academic value, have not been used with very good results. One of the most outstanding successes is the manufacture of glycerin by the fermentation of sugars with yeast. The normal products of this process are alcohol and carbon dioxide, together with small amounts of several other substances, one of which is glycerin. It has been found that by adding certain chemicals to the fermenting mash the amount of glycerin may be increased to about 36 per cent. of the weight of sugar. The production of glycerin for explosives during the Great War was a subject that occupied the attention of several countries, and although the fermentation process using yeast was not fully developed even at the end of the War, it was during this period that the pioneer work was done. Another chemical which was in great demand during the War was acetone, and this too proved capable of production by a biological process. A hitherto unknown organism was discovered —*Bacillus acetoethylicum*—which would ferment sugar and starch with the formation of appreciable quantities of acetone.

Citric acid affords another example of micro-organ-

isms being controlled to produce a product which hitherto had been known as a naturally occurring acid of the citrus fruits. Whereas up till a few years ago practically the whole of the world's supply of citric acid was obtained from these fruits, to-day a considerable amount is produced by the action of certain moulds on solutions of sugar. The exact organisms used and the method of procedure are closely guarded secrets, but most processes depend upon the use of moulds of the Aspergillus type, or Citromyces, the citric acid being neutralised continuously as it is formed, by the addition of chalk or other carbonates. In this way a very pure product has been obtained, and the supply is not dependent upon seasonal variations such as affect the supply of natural citric acid. Other acids also, such as lactic acid, are now manufactured by fermentation processes from sugar by employing different strains of organisms and by regulating the conditions of development.

Casein is another important product formed as a result of the activities of micro-organisms. It is used extensively in the manufacture of paints, moulding materials, and adhesives, and is prepared by allowing milk, from which the cream has been removed by centrifuging, to ferment by the naturally occurring Lactobacilli at 50° C. The curd which separates as the acidity increases is pressed.

Before leaving this branch of the subject mention should be made of power alcohol, the production of which has been greatly increased in recent years both in this country and in the U.S.A. Most of the processes used involve the fermentation of industrial molasses with yeast and subsequent distillation of the alcohol.

A Source of Vitamins.

The production of alcoholic beverages by fermentation has already been dealt with, but many other foods are dependent on the activities of micro-organisms. Since the value of vitamins as accessory food factors became established the importance of yeast as a source of vitamins B1 and B2 has been widely recognised and extracts from yeasts have found favour both as human and animal foods. The amount of yeast may be increased by adjusting the temperature and the amount of air.

An example of modernisation is provided in the manufacture of cheese, which, although an old art, has benefited extensively in recent years by the application of bacteriology. Whereas formerly the clotting of the milk and the subsequent ripening of the cheese was effected by a mixture of whatever organisms happened to be present, the correct type of organism is now introduced by the addition of the desired culture. A similar practice is met with in the manufacture of butter: "starters" are employed to sour the cream under controlled conditions. Many different species of organisms are used for this purpose but one of the best is *Streptococcus lacticus*. The use of yeast in the manufacture of leavened bread dates back to very early times but the employment of other organisms in this connection is a much more recent practice. It has been found that if the milk to be used for bread making is first fermented by an organism such as *Bacillus subtilis* and is then used in the normal way, only about one-half of the amount of yeast normally used is necessary. The fermentation of the milk in this way before the addition of yeast affords a supply of partly digested food for the yeast.

Help for Agriculture.

The employment of micro-organisms in agriculture has occupied the attention of bacteriologists for many years, and many discoveries have been made to show their importance. After discovering the changes which bacteria bring about in soil and in fodder it has become possible to control these changes to a certain extent. An example of such control is the preservation of green fodder in silos: by this method the material to be treated is packed tightly into large containers or pits where naturally occurring bacteria of the Lacto bacillus group develop, with the formation of lactic and other acids. These acids preserve the food against attack by the putrefying bacteria for long periods.

Micro-organisms have proved to be of great importance to a great variety of industries in addition to the foregoing. The ageing of tobacco is dependent on the action of micro-organisms, which are responsible for the formation of certain flavouring substances. Another industry where one would hardly expect to find bacteria being utilised is the textile industry. In the manufacture of linen, flax is "retted" by fermentation with bacteria. The easily decomposable substances are digested, leaving the fibre.

Only a few of the more important applications of micro-organisms to industry have been mentioned above but these will probably serve to show the extent to which industry is indebted to the activities of these microscopic cells. Or perhaps it would be more correct to say that industry is indebted to man's control of the activities of these organisms, for generally speaking the most useful results have been attained by merely organising the normal life processes of the organisms, rather than by the culture of new organisms to perform new work. In many cases organisms which are now used to perform work under controlled conditions have been known, and made use of, under partially, or entirely, uncontrolled conditions for many generations.

An Improvement in Motor Lamps.

By T. W. MacAlpine.

ALTHOUGH the average speed of travel on the open road has increased threefold or, perhaps, rather more* in the last 100 years, nevertheless the method of using lamps on vehicles as warning signals has undergone little or no change in principle within that period.

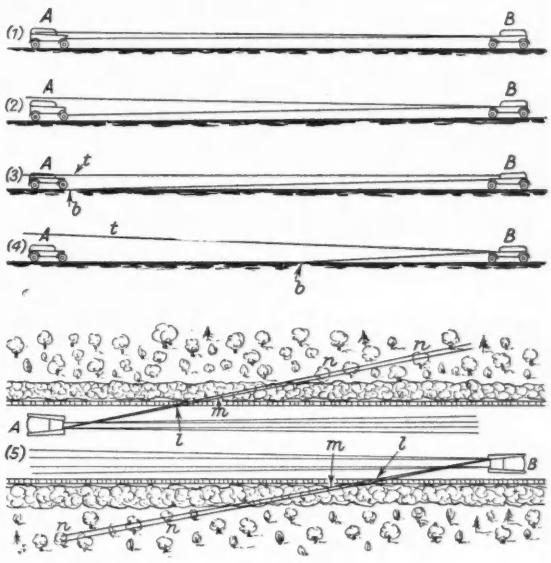
It is true that the vehicle lamp has been greatly improved in recent years: in maximum intensity of illumination, in the shape of the beam projected, as well as in the control of its intensity and direction, car lamps have now been brought to so high a state of excellence that the carriage lamps in use even so recently as forty years ago can hardly be compared with them. But vehicle lamps are intended primarily, in fact, mainly for the purpose of giving warning to other users of the road, and it is in this respect that the method of using these lamps has not kept pace with the improvements just mentioned.

Let us take a concrete case: The driver of a car (*A*) notices a lamp (or lamps) some distance away on the road, and his thoughts may be translated into the following: "That is some sort of vehicle ahead there, which is either approaching or standing still." And, with the intention of getting ready in good time to pass it, he keeps the lights in view. Now, the most important consideration for him at this stage and onwards is that he should have at least a rough idea of the speed at which the two vehicles are approaching each other, but there is nothing except the light from the other vehicle (*B*) that can help him to judge this.

Should the beam from the distant lamp (*B*) be comparatively narrow, i.e., nearly parallel (Fig. 1) or in the form of a cone of very small angle at the apex (Fig. 2) and projected straight at the driver in *A*, it is not easy for the latter to gain quickly even a rough idea of the speed of approach, as under such conditions it can be judged solely by the growing intensity of the light. (But it is a well-known fact in optics that the amount of light reaching the retina of the eye alters very slowly as we approach lamps throwing beams of the forms shown in Figs. 1 and 2.)

Alternatively, suppose the beam from *B* is large (Fig. 3) or of a wide angle (Fig. 4) and that car *A* and everything near it—road surface, trees, walls, hedges, etc.—are well inside the border of a field of brilliant illumination, then, here again, the driver cannot quickly judge the speed of approach.

On the other hand, should *A* detect the boundary between light and shadow (*b*, Figs. 3 and 4) moving along the road surface, walls, etc., he has at once a means of judging the speed of approach, since this boundary is travelling at exactly the same speed as the car *B*, which projects the light. But this border line, even if detected, may pass out of *A*'s field of view while



Demonstration of the advantages of a side-beam: the lower figure shows clearly how the beam can be followed as it strikes the objects bordering a country road.

the cars are still some distance apart, or, should the rays strike the ground, walls, etc. at a very acute angle, it may be difficult because of diffusion to discern a boundary between light and shadow.

It is true that this acute angle would cause no difficulty where there are isolated objects such as trees and bushes along the sides of the road, or even irregularities on the road surface. We all know how tree after tree in turn leaps out of the shadows, as it were, brilliantly illumined by the lamps of an approaching car, and how this effect helps us to gain a very fair notion of the speed of approach.

Let us apply the facts discussed above, and construct a lamp provided with means by which the car, when travelling on country roads could throw a side beam in a diagonal direction.

In Fig. 5, two cars, *A* and *B*, provided with the usual headlights, are also throwing diagonal side beams in a fixed direction; it will be seen that the drivers in both cars are well placed to detect in ample time the boundary line between light and shadow (*l*, *m*, *n*) which is moving along walls, hedges, trees, and so on.

*The mail coaches of a hundred years ago, taking one with another, maintained an average speed of nine miles an hour while post-chaises, gigs, and phaetons were anything between two and six miles faster.

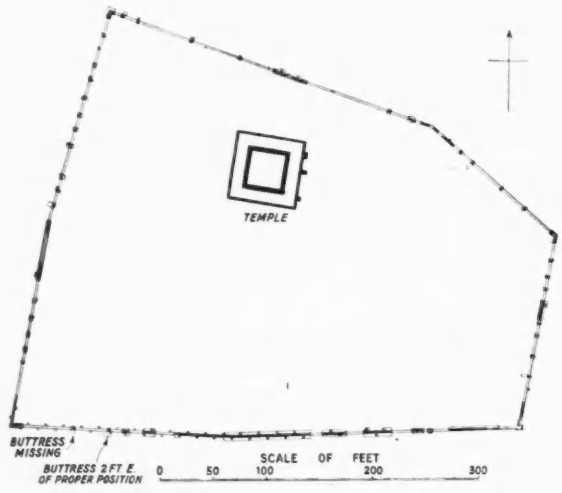
Cymbeline's Temple.

By Our Special Correspondent.

The site of this most important British excavation was specially visited for Discovery, *and the following details of the work, written on the spot, have been kindly supervised by the Director of Excavations, to whom we are indebted also for the illustrations.*

Now that the year's excavation season is drawing to a close, it is of interest to review the important work that has lately been carried out on the site of Cymbeline's city of Camulodunum, outside the walls of Colchester, by Mr. M. R. Hull, assisted by Colonel A. H. Burn and an enthusiastic company of helpers. As has been extensively reported, the chief discovery this year is the site of a Romano-Celtic temple with its enclosing wall, both of which present features of special interest.

It is a case of good coming out of evil, for the prime cause of the excavation was the announcement that a new model school was to be built on a field belonging to Sheepen Farm, which, it was practically certain, covered part of the site of Camulodunum. Practical certainty became absolute almost as soon as excavations were begun, and a portion of a long wall of undoubted Romano-British workmanship was very soon unearthed. One feature of this wall is unique, namely, that the buttresses, of about the same thickness as the wall itself, are placed *alternately* on opposite sides of the



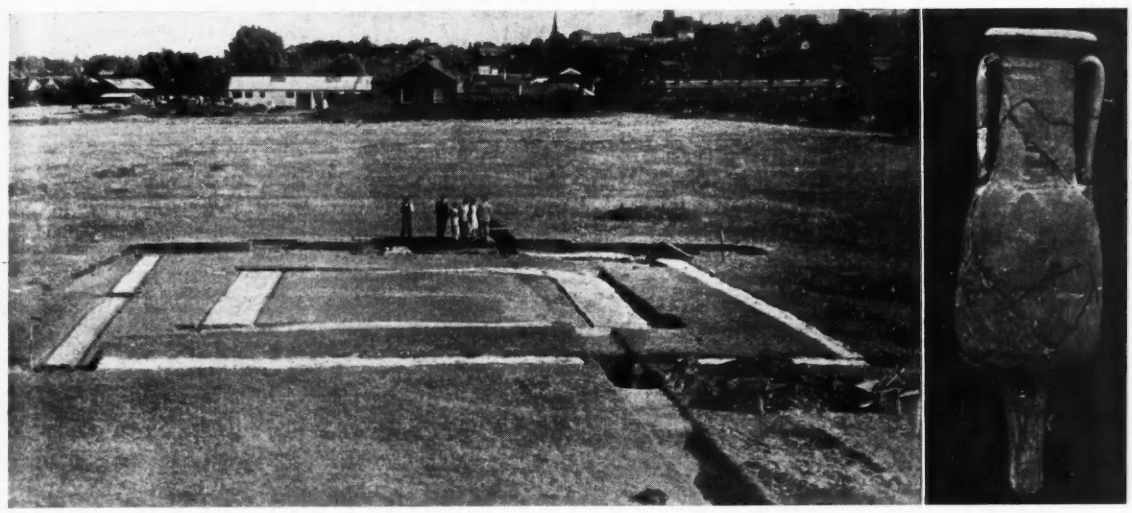
Plan of the Temple Enclosure at Camulodunum, showing clearly the irregularities of the site.

wall, the distance between adjoining buttresses on the same side being 17 feet. Any doubt as to the function of the wall was removed by the discovery that it turned approximately at right angles and that this second arm was succeeded by a third arm roughly parallel with the first. It was obviously an enclosure made for some important purpose. Some hesitation was caused by the apparent non-existence of the wall at the north-east corner, but experimental trenching brought to light the fact that this corner had been sloped off, making the enclosure into an irregular pentagon—not a quadrangle as had been expected. The reason for the cutting-off of this corner is not clear: it may have been due to marshy ground or to the existence of previous buildings on the site. The perimeter of the enclosure is roughly 1,533 ft.; the long south wall (the first to be struck) is 470 ft.; the west wall 384 ft.; the north wall 344 ft; the north-east wall 155 ft.; and the east wall 180 feet

Deliberate Destruction.

Obviously the next move was to find out what the enclosure enclosed, and trenching work soon revealed traces of a building lying somewhat to the north of the centre. These proved to be the foundations of a temple of the normal Romano-Celtic type, with two concentric square walls. The outer wall, about 64 ft. square, most probably supported a tile-roofed verandah, while the inner, some 30 ft. square, enclosed the cella of the temple, which would be lighted from above by a glazed lantern. An outstanding feature of the discovery was the way in which the building had been systematically destroyed, the walls having been literally razed to their foundations. A very small fragment of brick-and-rubble construction, in the south-east corner, is absolutely all that remains of them. No trace of any attribute of a deity has been discovered and the only portions extant of what was once a temple are some rough red brick tesserae from the floor of the "verandah," smoother white limestone tesserae from the cella floor, and broken roof-tiles and window-glass.

The entrance to such temples being almost always on the east, it was not surprising to find the important eastern outer wall 3 ft. in thickness, as against the 2 ft. 6 in. of the other walls; and a search for further proof was soon rewarded. Just outside the middle of the east wall a stepped plinth of Kentish limestone, 5 ft. square, was located, topped by the decayed remains of a Purbeck marble column 15 in. in diameter. Por-



The larger photograph, looking east, shows the temple site marked out, with the town of Colchester rising above it. Traces of the trenching for the enclosing wall are just perceptible half-way across the field. On the right is the 1st Century amphora found on the site.

tions of the original plaster facing remained on the south, and to a less extent, on the north side of the base. It is not unnatural to suppose that this column served as an altar or as the base for a statue of the tutelary deity. Half way between this plinth and the north-east corner of the temple, remains of a smaller plinth (for a subsidiary altar ?) were found, and packed rubble foundations for a second similar plinth were discovered in a symmetrical position towards the south. Immediately in front of the central plinth, about 8 ft. due east, a roughly cylindrical mass of packed rubble was later unearthed. What this represents is still quite conjectural, but it may be suggested that if the central plinth bore a statue of the god, this foundation may have supported an altar for offerings. One further curious fact is that no trace of an entrance or passage through the enclosing wall of the temple-area has been found, though one on the east side was to be expected.

Further excavations within the cella have brought to light older occupation-levels and hearth-marks, revealing that the site was used before the present temple was built, but up to the time of writing no trace has been found of the votive burnt-offering which it was customary to make at the foundation of even domestic buildings among the romanised people of Britain. Among the miscellaneous objects discovered on the site, mention must be made of the fine 1st century amphora (illustrated herewith) dug up towards the south-west corner of the enclosure, and of part of a pottery lamp bearing a figure of Mars. Coins found on the actual temple-site include some good examples with the head of Cunobelin (Cymbeline), a coin of Nero, and one of Valentinian II (375-392), apparently indicating that a temple on this site was in use throughout practically the whole of the Roman occupation of Britain.

The architect's pegs already mark out the ground-plan of the new school, and unless more funds are rapidly forthcoming the excavation will have to be abandoned with many interesting problems left unsolved. An account of previous excavations at Camulodunum, by Mr. M. R. Hull, the director of the work, may be obtained from the Castle Museum, Colchester.

Indian Peoples.

PART III of Volume I of the Census of India, 1931 (Government of India Publications, 13*s*.) which has recently come to hand, is far more than a series of statistical tables. It is divided into two sections: (A) Racial Affinities of the Peoples of India, by Dr. B. S. Guha; and (B) Ethnographic Notes, by various authors, edited by J. H. Hutton. Many discoveries have occurred since the last publication of the kind was issued in 1901; the finds at Mohenjo-daro, for instance, have upset one of the principal anthropological conclusions of Sir Herbert Risley, hitherto the greatest authority on Man in India. The tables of racial affinities are most illuminating, and a series of excellent photographs of the less known tribes adds much interest to an already valuable work.

Book Reviews.

Origins and Development of Applied Chemistry. By J. R. PARTINGTON. (Longmans. 45*s.*)

This is the first book of its kind and its closely packed pages will give to students, both of chemistry and of archæology, an immense amount of information. Dr. Partington has, perhaps, not made it quite plain in his title that he has in fact compiled a veritable encyclopædia of information concerning the invention, manufacture, and use of all material substances employed by man in the early stages of civilisation. The book is divided into sections geographically. Egypt, Babylonia, Ægean cultures, Persia, Phœnicia and Palestine are severally treated. In each section the author discusses the origin and use of metals, ceramics, textiles and all organic or inorganic substances of which we have knowledge from excavation-reports or from literary record. The result is for the archæologist of the greatest importance, for here he will find clearly stated the true chemical facts about the substances with which he deals. Processes of pottery making and firing, modes of smelting metals, detailed analyses of faiences and glass, all provide a mine of accurate information. Each section is preceded by a brief summary of all the known archæological and historical information about the area in question. The sections on Egypt, the Hittites, and Phœnicia are models of conciseness and accuracy and the amount of purely archæological reading which the author has been compelled to do is astonishing. And he has assimilated the information with singular success, seeing that he does not pretend to be a professional archæologist. It is quite clear that in future Dr. Partington will be the authority to whom all archæologists will come with their small scientific troubles, for he has evidently mastered both the facts of archæology and the difficulties that face the excavator. Indeed no praise can be too high for this very remarkable book, which contains exactly everything that the field archæologist can want. Nor will the pure chemist fail to profit by it. Usually the chemist rarely probes the origins of his materials and he will find much to surprise him in this book. The history of metallurgy is strange enough, but the history of many other inorganic substances is still stranger. The author is to be congratulated on an immense task admirably accomplished. The standard of accuracy is high and no misprints were detected. Most gratifying is the discovery that the author has really consulted all of the 25,000 references that he gives in his footnotes. For scientific archæology no such important book has appeared for a generation. There is certainly no other book in English even remotely to be compared with it.

S. CASSON.

An Introduction to Hydrostatics and Mechanics. By A. E. E. MACKENZIE. (Cambridge University Press. 3*s.* 6*d.*)

It would be a great pity to treat this admirable little volume merely as a school text-book, though it is well provided with the examination questions and other suggestions necessary for such a manual. The fact is that school and examination books now offer so much better a market to the author than any other type of writing, except the popular novel, that some of the best brains are attracted to their production. Mr. Mackenzie possesses one of these brains, and has used it to very good purpose in compiling this book, which is one of three to cover the whole field of physics; the others promised being on Heat, Light and Sound, and on Electricity and Magnetism. This reviewer has read it with pleasure and growing interest, being carried on rather to his surprise from point to point, even including the easy mathematics. It is interesting afterwards to analyse the qualities which have produced this effect.

The first, and most obvious, quality is the clearness both of the thought and the language. These could hardly be bettered, and they are directed by the author, not primarily to instructing the reader but to making him think. The motto proclaimed in the Preface of treating the child's mind "not as a vessel to be filled but as a torch to be kindled," is consistently followed throughout, and older people whose minds are less ready to be kindled than those of the young, should be even more grateful for the keen method adopted. "Try this" and "Think what this implies," are injunctions constantly repeated.

One notices next the excellent arrangement and sequence of the matter. Mr. Mackenzie is a mathematician, as befits his subject, but he is a reasonable and merciful one. One begins with the simplest conceptions and instruments of measurement, and Galileo's work—the crown of the whole—is not reached till the last chapter. In between, as we pass from questions of the pressure of air and liquids to the mechanical powers and the general theory of machines, the path is enlivened by descriptions of all the most interesting mechanical objects which meet our eyes every day in the modern world. Cars, cranes, divers, dams, and aeroplanes, all play their part, and he would be indeed a well-instructed person who did not find in every case something fresh and enlightening which he had not thought of before. It might be thought that such profusion of good matter in 255 pp. must mean congestion and dullness. Nothing is farther from the case. The book goes easily from point to point with unflagging interest, and so great is the skill and reasonableness of the author that he is able to include, with all the perfectly accurate and sufficient account of contemporary machines and the thought which they involve, an equally sufficient account of the work of the great pioneers in the past to which we owe them.

This is indeed the crowning merit of the book. It is commonly thought that we should first understand the state of any science, or the machines with which we have to deal, and that then afterwards, if we have any interest that way, turn to the history which led up to them. Mr. Mackenzie shows that it is quite possible, and adds very much to the current interest, to interpose at suitable places a few words about the great man who had enabled some crucial step to be taken. This is never overdone and is always to the point. We actually get a little life-sketch of Galileo in a page and a half, after we have learnt his greatest achievements, and the scattered references to Aristotle, Archimedes, Guericke, Stevin, Pascal, Boyle, Maxwell and Hertz, besides the full portraits of Galileo and Newton, make the book a pleasing picture of human effort as well as of clearly stated results. These names are but a few of those which occur, all of them quite naturally, doing their work, and recorded as doing it when the occasion suggests their remembrance. One may hope with confidence that the two remaining volumes will be as good as this and congratulate both the author and the Cambridge Press on their success.

F. S. MARVIN.

An Historical Geography of Europe. By GORDON EAST. (Methuen. 15s.)

Historical geography, like the historical side of science generally, has been too long neglected in this country, and every advertisement of the existence of such a science is a step forward. Mr. East's book, however, is more than that: it is the fruit of many years' work, even though, in the very nature of the subject, it must be incomplete. No one is better aware of this than the author, and in his preface he disarms criticism by the very fair admission that "the complexities of European culture, in the past as in the present, make it virtually impossible to treat the human geography of Europe as a united whole." Always bearing this proviso in mind, it may safely be said that Mr. East has made a contribution of the highest value to the study of social progress.

The book is divided into three sharply distinct sections: the Geography of Settlement; Political Geography; and Economic Geography; each of which could quite well stand alone. The first begins with the establishment of the Roman Empire in 27 B.C., purposely ignoring material dealing with the vast subject of community-structure prior to that date. One of the most interesting chapters in the whole book is that concerned with mediæval towns and routes, and the two main theories of town-origins—what may be called the natural and the artificial theories—are carefully discussed. In Belgium, for example, it is pointed out that by far the greater number of towns occupy arbitrary sites selected by a lord, either temporal or spiritual, whereas, in France, most of the great cities occupy Roman (possibly pre-Roman) emplacements.

In the second section Mr. East wisely restricts himself, after the first chapter on state-building, to typical instances of various geographical state-forms: the Byzantine Empire, a dwindling power with a strong topographical centre; the Arab wave along the Mediterranean, a naturally land-going movement forced by geographical circumstances to become maritime; and artificial polyglot confederations like Switzerland and Belgium, and so on. We are told why Cairo is the capital of Egypt, and Moscow that of Russia. Sicily is very aptly chosen as a complete microcosm, offering an excellent illustration of the changes in human geography which correspond to the vicissitudes of history.

The third section, dealing with economic geography, opens with a quotation from Gilbert White, rightly, if somewhat obviously, pointing out that trade widens the horizon of civilisation; and goes on with a discussion of the principal trade-routes of the Mediterranean, the Baltic, and the Atlantic, followed by the Danube as a typical example of an inland transport-route in pre-railway days. A chapter on the development of Europe in the railway era leads up to the Epilogue. Here the very pertinent point is made that "at a time when great advances in the means of communication have minimised distance . . . the nations of Europe select the smallest areas within which to develop their national cultures," although the concept of a United States of Europe would present no technical difficulties on account of mere area. Though Mr. East does not actually say so, he implies that a more intensive study of Historical Geography might be a cure for the present craziness of Europe. It may well be so.

The book is not without its blemishes, but they are rather matters of detail. There are some very odd spellings of place-names here and there, some apparently old-fashioned, some definitely wrong. It is difficult to believe that the olive ever flourished in the icy hill-winds of Jaca (p. 207); and why *should* there be any roads across the Plain of Catania (p. 296) apart from that which leads to Lentini across its seaward verge? They are not needed. Also the parallel (p. 293) between the Sicilian *dialect* and the Provençal *language* is hardly a fair one. These are relatively small points and detract little from the importance of the volume, still less from its good intention. An excellent bibliography and a good index, which might be fuller, add to the value of the book as a work of reference.

British Scientists of the Nineteenth Century. By J. G. CROWTHER. (Kegan Paul, 12s. 6d.)

Mr. Crowther has made for himself a considerable name as a scientific journalist. He has read widely; he takes great trouble with his material; and he gives actuality to what he writes by visiting laboratories and scientific institutions and talking there to the right people. He is inclined to stress—some of us think unduly—the sociological significance of scientific work, that is, the relation between scientific ideas and the social characteristics of their time. This point, a great one with the Russians, has generally been overlooked by our writers of scientists' lives, and partly because it is novel it may seem perverse to many of us.

Mr. Crowther has picked out five great British physicists and chemists of the 19th century, examined their lives and achievements in the light of modern knowledge, and given judgments about them. His men are Sir Humphry Davy, Michael Faraday, J. P. Joule, Lord Kelvin, and James Clerk Maxwell.

There is room and to spare for a book of this kind. The official and even the unofficial biographies of these men are not satisfactory even to students of science; and for the general reader they are dull. It is clear that nobody originally tried to do for any of these men what Lockhart achieved with Scott or Froude with Carlyle, and there has been nobody since, like Lytton Strachey, to attempt brightness or readability at the expense of fact. Mr. Crowther's book is a real contribution to biography; its standard is high; its merit is that it contains in interesting form most that is apposite and vital in the material available. The characterisation of the men is good and it is interesting to have them judged from the standpoint of to-day. It is obvious that Mr. Crowther sets value on his remarks about the relation of these men to society. He thinks and is concerned to show that the French Revolution had a deep influence on the careers of both Davy and Faraday. He argues that Davy became great by "selling science to the industrialists." (Surely an odd comment on Davy!) He sees in Thomson's (Kelvin's) career the consummation of the process which Davy so brilliantly advocated. He thinks the chief social significance of both Kelvin and Clerk Maxwell lies in their making physics a University study, so that these homes of learning became useful to the industrialists. Less controversial and more sound are the judgments about the present reputations of the five. Faraday's reputation remains, the author thinks, as it was—at the very top of the tree. Davy's researches were more brilliant than is commonly accepted. Kelvin was a greater personality than scientist; a great "applied" man, not a begetter of fruitful theoretical ideas. Joule, he thinks, was the most extraordinary genius of his time. He talks of his "immense genius." And Clerk Maxwell was far greater than even his best contemporaries thought. It is about Joule that many will join issue with the author.

In his sociological judgments Mr. Crowther is much more

provoking. He draws a parallel between Faraday's religious position—a Nonconformist of Nonconformists—and his very individual work on science that is surely unwarranted. He tries to explain sociologically why Davy was a snob, and why Kelvin gave up pure science and went in for applied electricity and money making. Faraday had a face like an American, therefore, etc. All this kind of thing has interest, but a reader gets a distinct impression that if things had been quite otherwise the explanation would have been just as pat.

Nevertheless, even if a reader gets a bit tired of this "bourgeois" emphasis he will enjoy the book. He will learn a lot from it. He will be stimulated by it. It should be widely read. The welcome it deserves will encourage the author, we hope, to continue his writing on biography.

A. S. RUSSELL.

The Folklore of Morocco. By FRANÇOISE LEGEY. (Allen and Unwin. 12*s.* 6*d.*)

Moroccan folklore has a lure which may spring from memories of the *Arabian Nights*, but endures in virtue of its intrinsic interest. For in Morocco the concepts of Moslem cult and earlier Arabian survivals are entangled in indigenous belief and mingled with fragments from the interior of Africa, the Mediterranean, ancient Rome, and even the hinterland of Europe. From this composite pattern Mme Legey is content to select and has attempted no analysis. As, however, she has a knowledge of Morocco which extends over a residence of fifteen years, and a mind quick to seize upon details that open the way to the inmost thoughts of the people, she has collected a store of material which will be more than welcome to the folklorist. Her supreme achievement is the collection of information which has been withheld from other observers, but to which she has had access as a woman, a doctor, and an officer of the French Government. Her record of women's beliefs connected with the sexual functions, childbirth, the early care and upbringing of children, and kindred topics is of supreme value and interest.

Knights Errant of Papua. By LEWIS LETT. (Blackwood. 12*s.* 6*d.*)

Papua, formerly British New Guinea, is a remarkable example of the success of a policy of peaceful penetration in a country which is naturally difficult and among natives who are temperamentally uncertain. Local conditions fully justify the application of the title of knights errant to the patrol officers and other members of the administration of Papua, whose records have been skilfully woven into a continuous narrative by Mr. Lett.

The policy of the small patrol, usually consisting of two white officials, native police, and bearers, has been brought to a high pitch of efficient service in the pacification of the territory by the enthusiasm of Sir Hubert Murray, who has acted as the chief administrative and executive officer since the territory was taken over by the Australian Government in 1907. Mr. Lett himself has been a civilian resident in New Guinea for twenty-five years, and his graphic narrative is informed by intimate knowledge of the country and of the individuals whose tale is told. The story is brought down to 1927 when Karius and Champion made their memorable journeys across the broadest part of New Guinea in search of the head-waters of the Sepik River and a way across the great barrier into the Mandated Territory.

To those who appreciate a true story of adventure, thrilling in its encounters with savages, mishaps stoically endured, and difficulties finally overcome, Mr. Lett's book may be commended cordially.

Sex and Temperament in Three Primitive Societies. By MARGARET MEAD. (Routledge. 10*s.* 6*d.*)

Dr. Margaret Mead, by her studies of certain aspects of primitive societies in New Guinea and Samoa, has already established a reputation as a field anthropologist, whose keen powers of observation in matters of detail never obscure her ulterior object of arriving at underlying general principles which can be applied in a wider field than that with which she is immediately concerned. In the present volume the contrast in character and outlook presented by three neighbouring communities on the Sepik River in New Guinea, which were under her observation in an expedition in the year 1931-3, has led her to the general conclusion that the usual distinction between the sexes in character and function (physiological function apart) is not one in which sex is really the determining factor, but one for which social convention is responsible. In other words that the distinctions usually drawn are not sex-linked but socially determined.

In the light of this conclusion Dr. Mead turns from the simpler forms of society in New Guinea to the complex civilisations of European type and finds, in the rigid application of the sexual principle, an explanation of the opposition of the contrasted ideals of the *hausfrau* and the "modern" woman, as well as of the "misfits" and perverts of morbid psychology.

Dr. Mead has produced a stimulating book which is of interest to the anthropologist as a piece of careful observation and to the layman as a bold attempt to probe to the cause of certain elements of social unrest, as well as to suggest the lines of remedial measures. Whether Dr. Mead's generalisations are too wide for her basis of evidence or whether the societies under observation are too marked a departure from the normal for her conclusions to be generally valid may be left to the judgment of the reader.

Captain Kidd and his Skeleton Island. By HAROLD J. WILKINS. (Cassell. 12*s.* 6*d.*)

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